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Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. VIII. NEW YORK, NOVEMBER 1903. No. 9.

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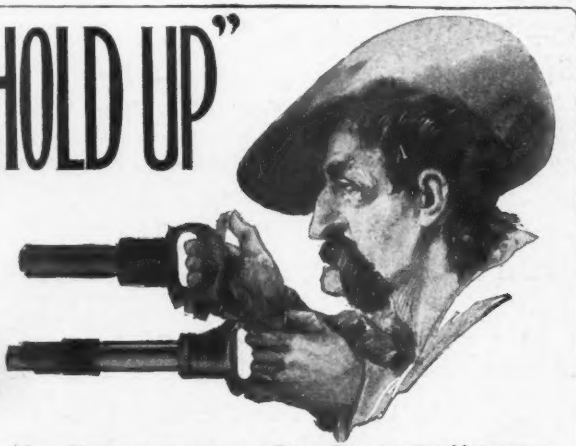

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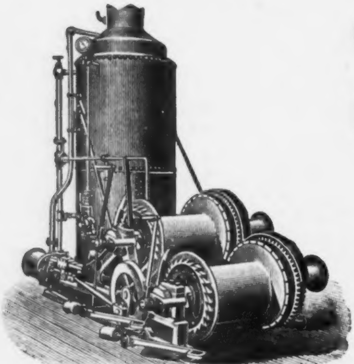

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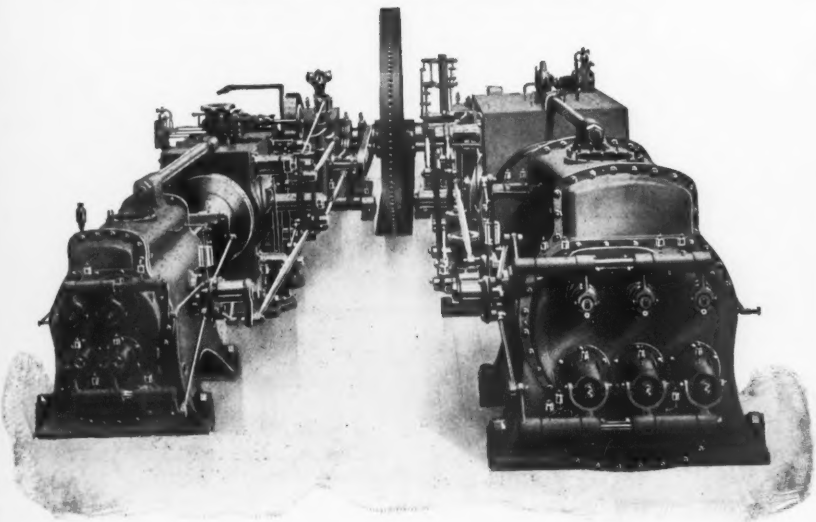

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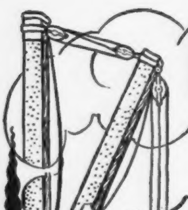

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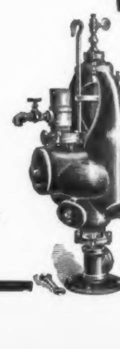

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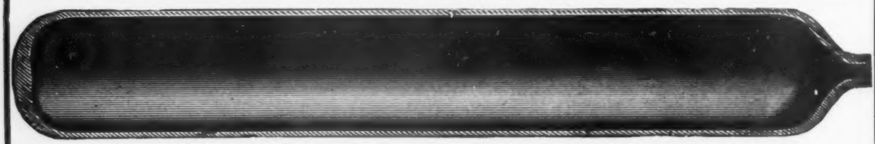

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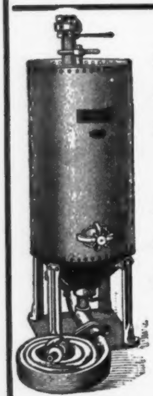

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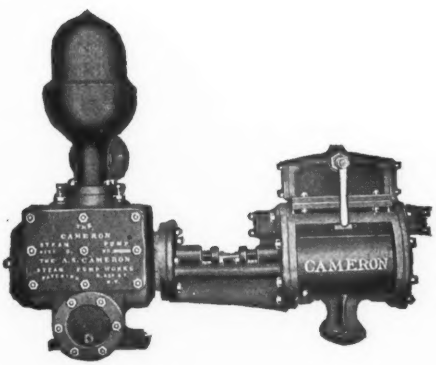

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6—If screens are used, state at what depth or depths, and kind of screen.
7—Depth from surface to water level when not pumping.
8—Depth from surface to water level when pump is in operation.
9—Size and kind of pump used.
10—The largest yield obtained from the well (or wells).
11—Quantity of water required in gallons per minute.
12—How far from the well will the air compressor be placed (approximately)?
13—How many feet from boiler to compressor (approximately)?
14—What is the working steam pressure carried?
15—If it is necessary to lift the water above the ground level, state how high.
16—If a belt driven air compressor is preferred, state kind of power available.

(***In addition to the above, please state the character of the liquid to be pumped, if it is other than water.***)

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VOL. VIII. NOVEMBER, 1903. NO. 9

Developing the Air Compressor.

The attention of makers of air compressors is being attracted more and more by the possibilities of the electrically driven compressor. Much has been said in COMPRESSED AIR about those apparently rival powers, compressed air and electricity, which are gradually coming to work in harmony with each other. That the coming years will see great developments along that line, any one who is acquainted with the progress of compressed air machinery cannot doubt.

The general movement among the manufacturers of the United States who use machinery of any size is to abolish the long lines of shafting, and to substitute the direct-connected or geared motors, supplied with current from one or more large generators in a central power station. Belt machines are still plentiful, but each new factory shows a tendency to eliminate much of the shafting and belts, taking advantage of the economies and greater safety which have been proven in almost every case to follow the introduction of individual electric motors for each machine. To meet these changed conditions, the designs of many machine tools and other labor-saving contrivances have been more or less altered. Air compressors will naturally be similarly affected. A wide variety of requirements for electrically driven compressors will preclude, for the present, at least, the adoption of any standard types, and such machines will in most cases continue to be designed to suit the demands of each individual case.

While the next few years promise a rapid development of these electric machines, it does not mean that the belt-driven compressor is to be superseded. It will tend rather to a further extension of the use of compressed air machinery. There was a time when the economical development of power in the air compressor was the least thought-of subject during its construction. Economy of floor space and small first cost were the principal considerations. The competition of electricity and the general progress of the age have combined to change this viewpoint. Now the compressor manufacturer is carefully considering the problem of securing the most economical results from the machine and is willing to sacrifice much toward accomplishing this end. The result is a wonderful improvement in the efficiency of compressed air machinery.

Among the recent improvements which have figured in this direction are the improvements in the efficiency and durability of the valves, the compounding of the cylinders with an intercooler between them, and the water-jacketed air cylinders. While the wisdom of cooling the air during the course of compression has been realized and this policy is being generally pursued, the advantages to be obtained by reheating the air just pre-

vious to its use do not seem to be so well appreciated. It is along these lines that some great economies can be and surely will be made in the near future.

Compressed Air for Railway Brakes.

There is no more important application of compressed air than as the power operating the brakes on the modern railway train. Since the advent of the railway air brake, wonderful improvements have been made possible in the running of trains, while the factor of safety has been greatly increased. While the locomotive brakes do not absolutely require air to operate them, no other arrangement has yet been found which will in any way fill its place in controlling the brakes of an entire train.

It is only of late years that the use of air on freight trains has been general. This has been brought about through legislation. There can be no doubt that these brakes greatly reduce the danger of operation in the freight service. Failure, however, to take advantage of these brakes or attempts to operate them improperly still result in occasional accidents. The friends and advocates of this system should do all in their power to extend an intelligent understanding of the brakes among the men who are called upon to operate them.

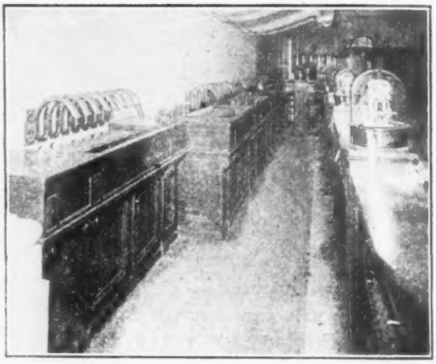
One interesting feature of the air brake question was discussed at length in a paper read before the Traveling Engineers' Association, bv Mr. Frank P. Rosch, of the Chicago & Alton Railroad, extracts from which are published in another part of this issue.

Pneumatic Tube System in the New York Stock Exchange.

There is probably no place in the world where such a volume of business is transacted within so few hours, where accuracy is so imperative, and speed such a factor as on the floor of the New York Stock Exchange.

In planning the erection of their new and palatial quarters in the building just completed, the Building Committee of the "Exchange," in addition to all the numerous details and modern improvements which go to make up the luxuries and comforts expected at the present day in a building of this nature, were confronted with a problem, which to the average layman and even the experienced member of the Exchange would seem to be beyond human power to satisfactorily solve.

Taking into account a few of the outside matters upon which to a large degree the business of the "Exchange" depends, notably the business with the several telegraph and cable companies,



THE ARBITRAGE DESK, WHERE MEMBERS WHO DO AN ARBITRAGE BUSINESS WITH LONDON OPERATE.

news bureau and messenger service, and the problem presented was, first, how to arrange a service so that two members of the Exchange sending telegrams or cablegrams at the same instant, by different companies, would be sure of their reaching the operators' hands simultaneously.

Second, how to arrange a service so that the several telegraph, cable and messenger companies would receive such messages without advantage to either, regardless of the distance of their offices from the floor of the Exchange. In addition to the above, it was also imperative that members should have the same

service from all portions of the Exchange floor.

As the number of members of the old Exchange had increased, the space formerly occupied by telegraph and cable companies, as well as messenger offices,

THE MEMBERS' DESK, ONE OF FOUR ON THE BOARD ROOM FLOOR.

had to be given up to the Exchange proper, and these companies had to seek new quarters.

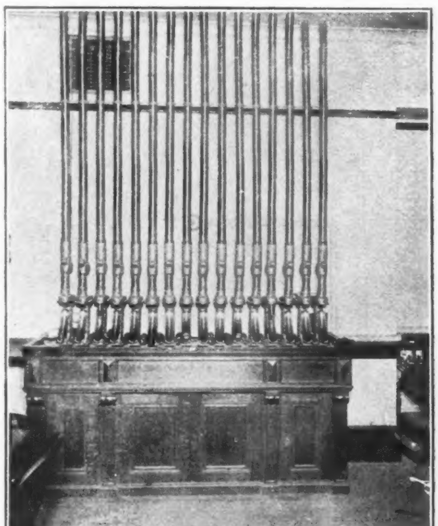
One of the telegraph companies had its office located immediately under the Stock Exchange Board and all the members had to do was to drop their messages, both telegraph and cable, through an opening in the floor to the room below, where they were picked up by messenger boys and turned over to the operators, whereas with other companies it was necessary for the members to go to the entrances of the Exchange and hand their messages to boys to take to companies in adjoining buildings.

It will be readily seen from the above how important a problem the Committee had before them, especially as the number of messages was generally from 10,000 to 15,000 during the five hours of each day's session of the Exchange, even without any unusual excitement in the market.

After a careful examination of all modern methods of transmission, the Building Committee finally decided on a system of pneumatic tubes as being the most satisfactory, because *sure, secret* and *safe.*

To ascertain the volume of business that would necessarily pass through the tubes an account was taken of all messages sent from the Exchange for several years previous, the daily average ascertained, and this amount *more than doubled* to allow for future growth. The future location of all the several outside companies was also ascertained and the length of pipe necessary to run from each to the floor of the Exchange. With this data the contractor proceeded to lay out, construct and install the plant.

There are 93 pneumatic tube terminal stations located on the Board Room floor; of these 70 stations connect with the various telegraph and cable offices; 10 stations connect with the Bond Department, one with the Secretary's offices, one with the Luncheon Club, one with the smoking-room, and the balance with the officers and other departments. Each station is designed to accommodate one carrier every five seconds, thus giving a capacity of twelve per minute. The time of transmission to any point is four seconds, irrespective of the length of the line, allowing one second for the



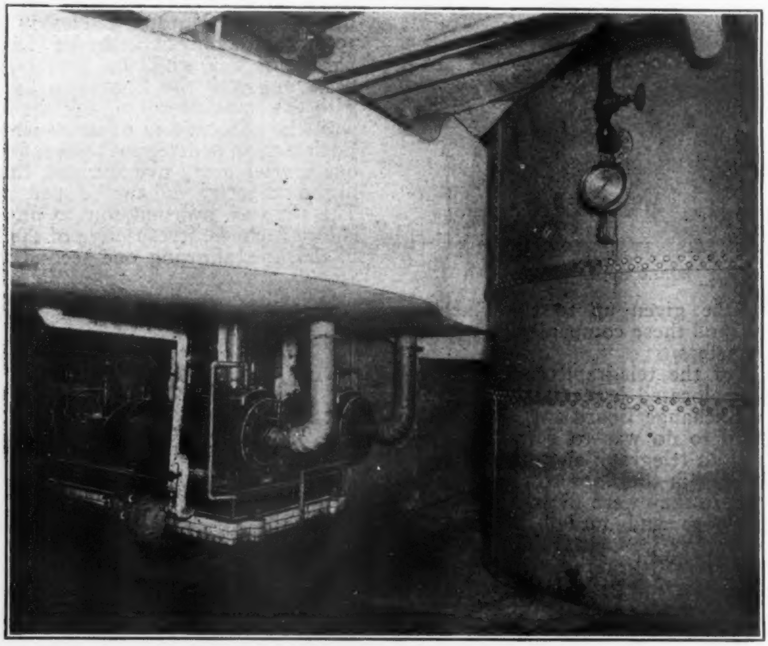
DESK OF THE WESTERN UNION TELEGRAPH COMPANY.

terminals to readjust themselves, giving a total capacity of 300,000 in a day of five hours.

The method of operating is as follows: After receiving a message intended for delivery, the carrier containing the message is placed in the tube and the terminal door closed. This operation automatically turns on the air behind the carrier, and forces it to the extreme end of the tube, or its destination; the air is then automatically shut off, the door opens at point of dispatch, and the tube is in condition to receive another carrier.

There are four central stations on the Board Room floor in addition to a separate station for members doing arbitrage business with Europe, all of which correspond with and carry out the elaborate scheme of decoration found throughout the entire building. The desks are of oak with marble back, corresponding with the wainscoting and pillars, and the terminals, themselves of rather ornate design, are finished in antique copper.

While a technical description of the method of operation of this plant would not be pertinent in this article, a rough outline may be of interest to the general reader. The system is known as a Pressure System, wherein air is compressed into tanks or reservoirs, and there held until required for the despatching of carriers. The compressors used in compressing air are of the duplex type, automatically controlled, such control being regulated by the air pressure in the reservoirs, thus giving an absolute equality of pressure at all times, under all conditions. This air is conveyed to the various stations by means of iron pipes, and at the different terminals is connected with the tube system.



AIR COMPRESSORS AND AIR RESERVOIR.

The tube system itself is of brass, with a diameter of 2¼ inches, all exposed portions being finished in antique copper.

The system is so designed throughout that power is only used as required, or in proportion to the work done, thus assuring the greatest economy, while its capacity is more than ample to meet any extraordinary conditions, or panic, should one arise.

A few of the many advantages gained over old methods in the transaction of business on the floor of the Exchange are the following. First, it does away entirely with messengers on the Board Room floor and eliminates the confusion that formerly existed in the old Exchange.

Second, it gives to each member the same service.

Third, each and every telegraph and cable company and outside messenger departments can receive their messages in the same period of time that their competitor does, regardless of their distance from the Exchange floor.

Fourth, the service is instantaneous.

Fifth, it gives increased space on the Board Room floor for members.

Sixth, there is no possible chance of delay through tardiness or dilatoriness of messenger boys.

EDMUND A. FORDYCE.

The American Mining Congress.

The American Mining Congress held its sixth annual meeting at Deadwood and Lead, South Dakota, September 7-12, many representative mining men from every part of the United States being present. The meetings of the Congress were divided about equally between Deadwood and Lead, each city vying with the other in the entertainment of its guests.

The Honorable Leslie M. Shaw, Secretary of the Treasury, addressed the Congress at its opening meeting on "The Mining Industry and its Relation to American Finances." We quote the following from this address:

"It is an error to rate the importance of our many industries according to their relative productiveness. Our factories and workshops produced $13,000,000,000 gross in 1900; agriculture, $4,000,000,000; forestry, $2,000,000,000, and mines, $1,000,000,000, about equally divided between metallic and nonmetallic products. Yet it must occur to all that manufacture—apparently our greatest wealth producing industry—is dependent upon iron, copper, lead, zinc and other metals, and equally upon coal and other nonmetallic minerals. Our manufacturing interests would dwindle into significance but for our mines.

"A people's prosperity is not measured by its capacity to produce more than by its capacity to consume, and this capacity to consume is in turn dependent upon the earning capacity of the individual, and the earning capacity of the individual is again dependent upon native and acquired ability. So, if America be great, it is because God in His wisdom stored the mountains with the richest minerals, overlaid the valleys with a most fertile soil, and then gave it to people competent, in some slight degree at least, to improve their opportunities."

Interesting and instructive addresses on Black Hills geological formations were presented by Dr. J. E. Todd, State geologist of South Dakota; Mr. Nelson H. Darton, of the Geological Survey; Dr. John D. Irving, of U. S. Geological Survey; Dr. C. C. O'Hara, of Rapid City, South Dakota; and Mr. John Blatchford, superintendent of Golden Reward Company, of Deadwood.

In the old Bullock Hotel building, at Deadwood, and in the Hearst Public Library building, at Lead, were shown very fine and instructive displays of Black Hills minerals. A number of the mining companies also sent in for display, for a few hours, gold bullion amounting to about $65,000.

Among prominent mining men from distant points the following were noted:

Mr. E. P. Low, of Honolulu, Hawaii, who spoke on "The Mining Resources of Hawaii."

Honorable E. W. Parker, of Washington, D. C., who addressed the Congress on the subject of "Coal."

Dr. J. A. Holmes, chief of the Department of Mines and Metallurgy of the St. Louis Louisiana Purchase Exposition, made an address on "Government Agencies for the Advancement of Mining" and "Mica Deposits of the Black Hills Region." Dr. Holmes also addressed the meeting on the subject of the "St. Louis Exposition."

An address on "The Supply of Gold" was made by the Honorable George E. Roberts, Director of the Mint.

Mr. C. W. Merrill, superintendent of the Homestake cyanide plants, read a very valuable paper on the subject of "Metallurgy of the Homestake Mine Ore."

Ample opportunity was afforded all visitors to the Congress to inspect the

mammoth plant of the Homestake Mining Company, at Lead, and on Thursday afternoon, through the courtesy of Superintendent T. J. Grier, the unusual opportunity was offered to members and delegates and their friends of a visit to the underground workings of this great mine. The entire mine, with the exception of the 700-foot level, was shut down for the occasion, and the visitors, nearly 600 in number, were taken down the Star Shaft to the 700-foot level, where they had a chance to inspect some of the mammoth stopes which have been worked out and others in which work is now progressing; also the manner of stoping, back-filling and timbering, which was of great interest to the practical mining men, most of whom had never before visited the Homestake Mine. From the Star Hoist the visitors were taken underground to the Highland, about a half mile distant, where they came to the surface.

The Homestake Company hoists to the surface every twenty-four hours about 4,000 tons of ore, and compressed air plays a very important part in the work of excavation underground, where the drilling is done by 223 air drills, of the following patterns:

216 Ingersoll-Sergeant.
3 Leyner.
2 Rand.
1 Sullivan.
1 McKiernan.

The compressed air to operate these drills is supplied by three huge Corliss air compressors, manufactured by The Ingersoll-Sergeant Drill Company. After the ore is hoisted to the surface, an air haulage locomotive, with its load of 28 four-ton cars, now accomplishes in one eight-hour shift the work of three shifts of steam locomotives. At present air haulage is used only on the 100-foot level, but arrangements are being made for testing air haulage on all the underground levels of the Homestake Mine.

The final meeting was held September 12, and the Congress adjourned to meet at Portland, Oregon, next year.

Westinghouse Electro-Pneumatic Turret System of Control.

The announcement was made in the *Railroad Gazette*, on May 15 last, that the Westinghouse Air-Brake Company had equipped the experimental car of John B. McDonald, of the Interborough Railroad, New York City, with a new system of electro-pneumatic train control. At the Saratoga convention of the American Street Railway Association this month a complete apparatus for one car in working order was exhibited for the first time. Following this, the details of the system are now given. The principal parts of the apparatus and their location and connections are shown in the accompanying engravings.

The new system operates on the same principle of electro-pneumatic control as is used in the original Westinghouse system. The method of accomplishing the movements of the main controller under each car is, however, radically different. All of the safeguards of the old system have been embodied in the new and with some additional ones. Current is taken from the track circuit and after passing through a lamp resistance is used for charging storage batteries from which the power is taken for controlling the pneumatic switches in the main circuits. The control leads carry only 14 volts, which eliminates danger from short circuits and accidents in coupling the wires from car to car in the train. By using storage batteries the control circuits are independent of the track cir-

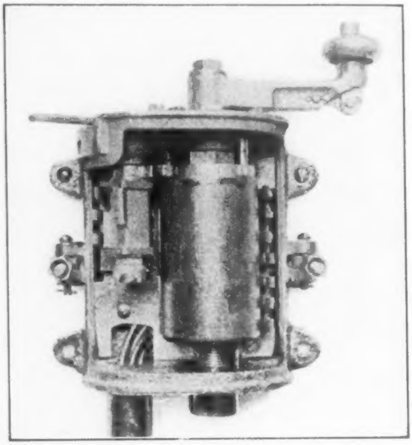


FIG. 1—MASTER CONTROLLER SWITCH, COVER REMOVED.

cuit and the motors can be manipulated even if a fuse is blown out or the third-rail de-energized. Compressed air for operating the pneumatic valves and switches is taken from an auxiliary reservoir connected through a feed valve to the air-brake train pipe. A check valve in the connecting pipe assures at all times a sufficient supply of air to provide against failure of the brake system so that both controlling current and operating power for the main switches are independent of any other apparatus under the car. The controller and reversing handles are interlocked and cannot be moved unless they are both in their proper positions of off or ahead or reversed. The controller handle has an automatic spring return to shut off the current in case of accident to the motorman, and is also connected to the brake system to apply the brakes when such an automatic cut-out is made. Power cannot be applied to the motors when the brakes are on or the brakes applied when the power is on. This is accomplished by the introduction of a pneumatic cut-out switch in the battery circuit which is connected to the brake cylinder and which opens whenever there is air pressure in the cylinder. The apparatus hereafter described is for one car only, but of course the control of any number of cars in a train is possible by conducting the battery wires from any master controller to all the turret controllers under the cars through a train cable. This cable consists of only seven wires carrying 14 volts, so there is little complication and no danger from high tension currents.

The apparatus for one car consists of a main controller, reversing switch, limit switch, resistances, two master controlling switches, 14 cells of storage battery, reducing valve, circuit breaker relay, supplementary reservoir, four 7-point receptacles and three junction boxes. As applied to the cars of the Interborough, the total weight for each car is 1,711

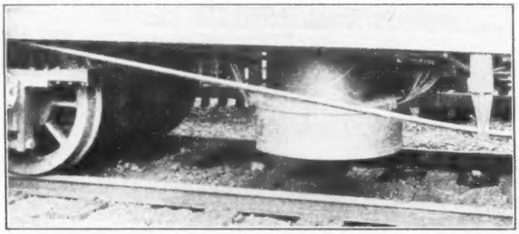


FIG. 2—TURRET CONTROLLER MOUNTED UNDER CAR.

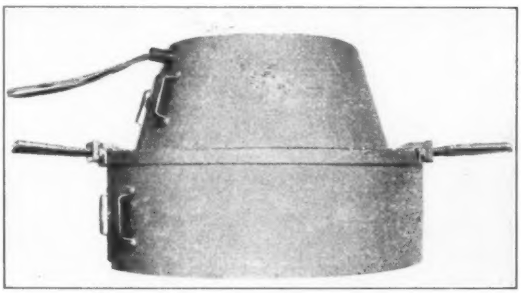


FIG. 3—TURRET CONTROLLER, COVER ON.

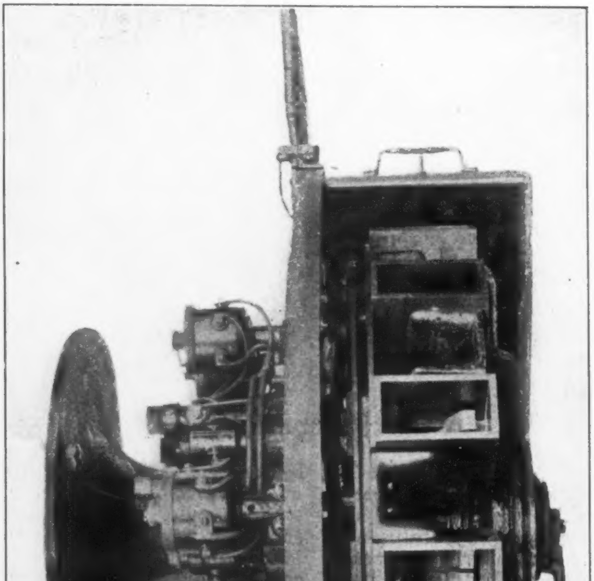


FIG. 4—TURRET CONTROLLER, COVER REMOVED.

pounds, exclusive of wiring and insulation. With the exception of the master switches, battery switches and junction boxes, all of the apparatus is supported from the floor under the car. The main circuit wires are carried up into the car at only one point, connecting to a main switch in one of the motorman's compartments.

In the motorman's cab at each end of the car the master control switch with the brake valve alongside are mounted on the end panel. The master switch shown with the cover removed in Fig. 1 is mounted with the handle 34 inches above the floor, or about level with the window sill. It is 7½ inches high, 6 inches wide and but 4½ inches deep, so that when not in use the door of the compartment may be swung back against the end panel and enclose the whole apparatus. The rotating cylinder is hard wood with copper plates and spring fingers. The battery circuit wires are brought out through the bottom of the switch box and down the panel to a junction box 13½ inches high, 5 inches wide and 3 inches deep, from which they pass through the floor to the pneumatic switches under the car and to the coupling plugs to the other cars in the train.

The main controller, Fig. 2, is hung from the floor of the car as near the track as possible to save wiring. The system takes its name of "turret" from the appearance of the cover as shown in Fig. 3.

Fig. 4 shows the controller with cover removed. Thirteen switches operated by air and controlled by magnetic valves, Fig. 5, are mounted around a central casting which serves as a reservoir to supply air to the pistons. These pistons operate against 70 pounds spring pressure, which insures a positive break to the switches and also allows any length of break necessary to prevent arcing. The 13 switches have one common blow-out coil located in the center of the turret. The arc is blown out radially since the magnetic field is horizontal due to the pole pieces for the blowout being formed by the arms of the spider supporting the switches. The contacts of the switches cannot weld or stick under the strong positive air pressure moving them, and by making the finger levers flexible there results a slight rubbing of one contact surface over the other which further prevents any welding or roughness. Several of the switches move together so that only eight pneumatic cylinders and valves are required for making all the necessary contacts. The section of the controller, Fig. 6, shows the arrangement and general dimensions of the valves and switches.

Figs. 7 and 8 show the reversing switch with cover on and removed. This is mounted under the car, near the truck, and is of the reciprocating type with copper contacts. It is operated by two pneumatic valves admitting air on opposite sides of a piston, and connected to

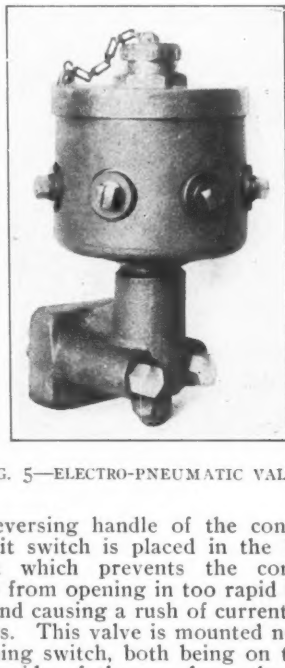


FIG. 5—ELECTRO-PNEUMATIC VALVE.

the reversing handle of the controller. A limit switch is placed in the battery circuit which prevents the controller valves from opening in too rapid succession and causing a rush of current to the motors. This valve is mounted near the reversing switch, both being on the opposite side of the car from the resistance.

The wiring diagram, Fig. 9, shows the connections for one car. The switches 1 to 13 are controlled by the solenoids shown above them. Nos. 1 and 2 work together and control the circuit breaker. Nos. 3 and 11 together make the series connections, and Nos. 5 to 10 act successively through the limit switch in cutting out the resistance on the third

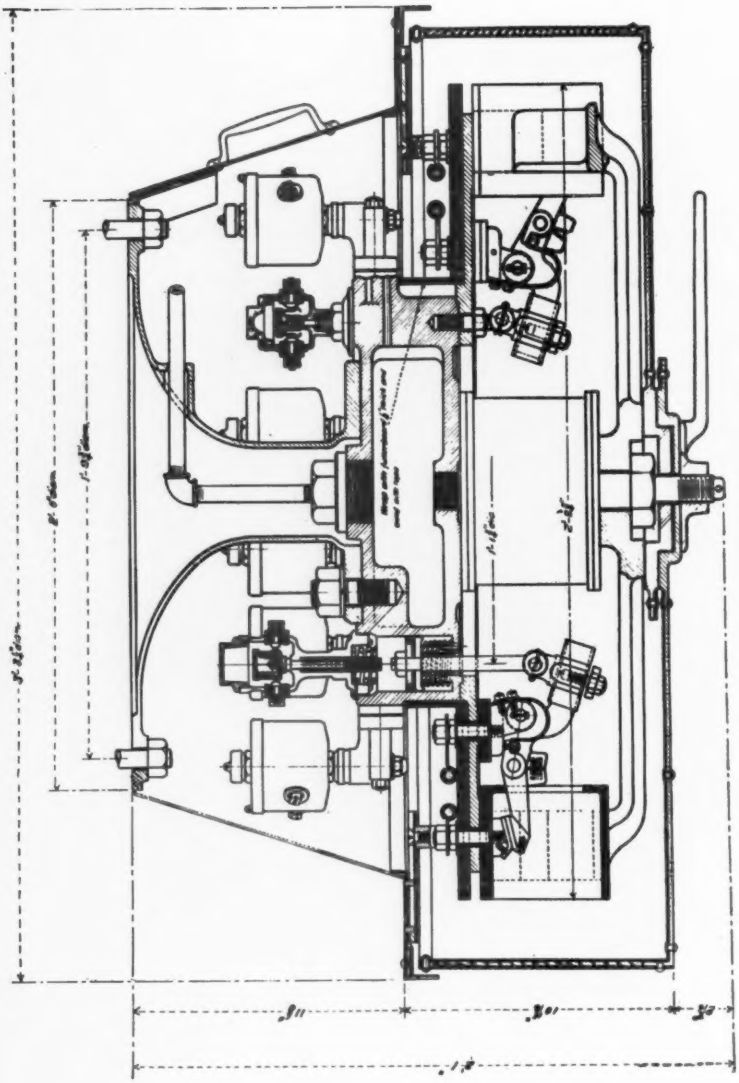


FIG. 6—SECTION THROUGH TURRET CONTROLLER.

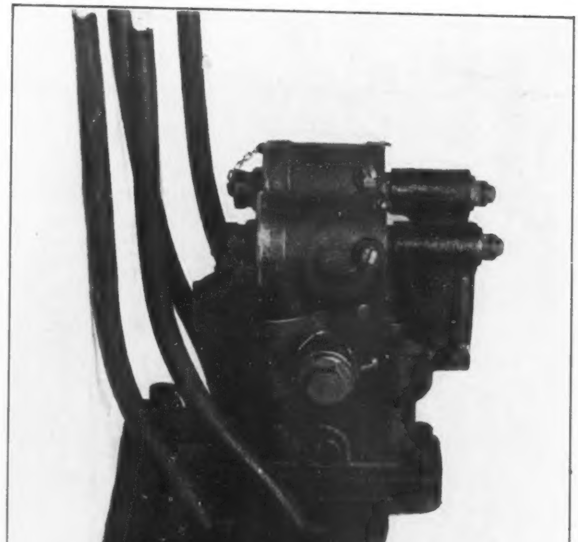


FIG. 7—REVERSING SWITCH, COVER ON.

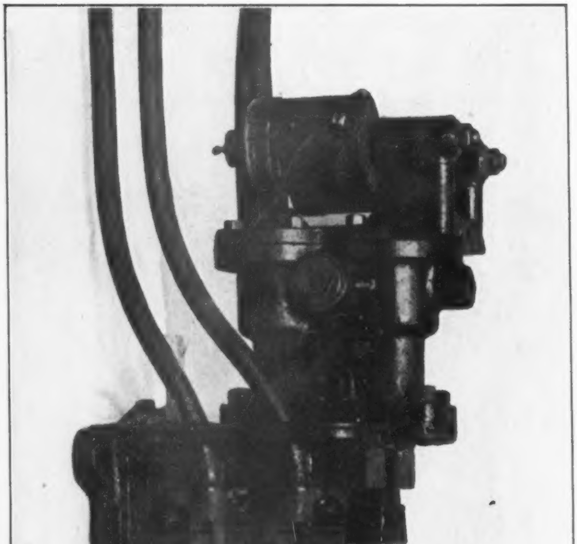


FIG. 8—REVERSING SWITCH, COVER REMOVED.

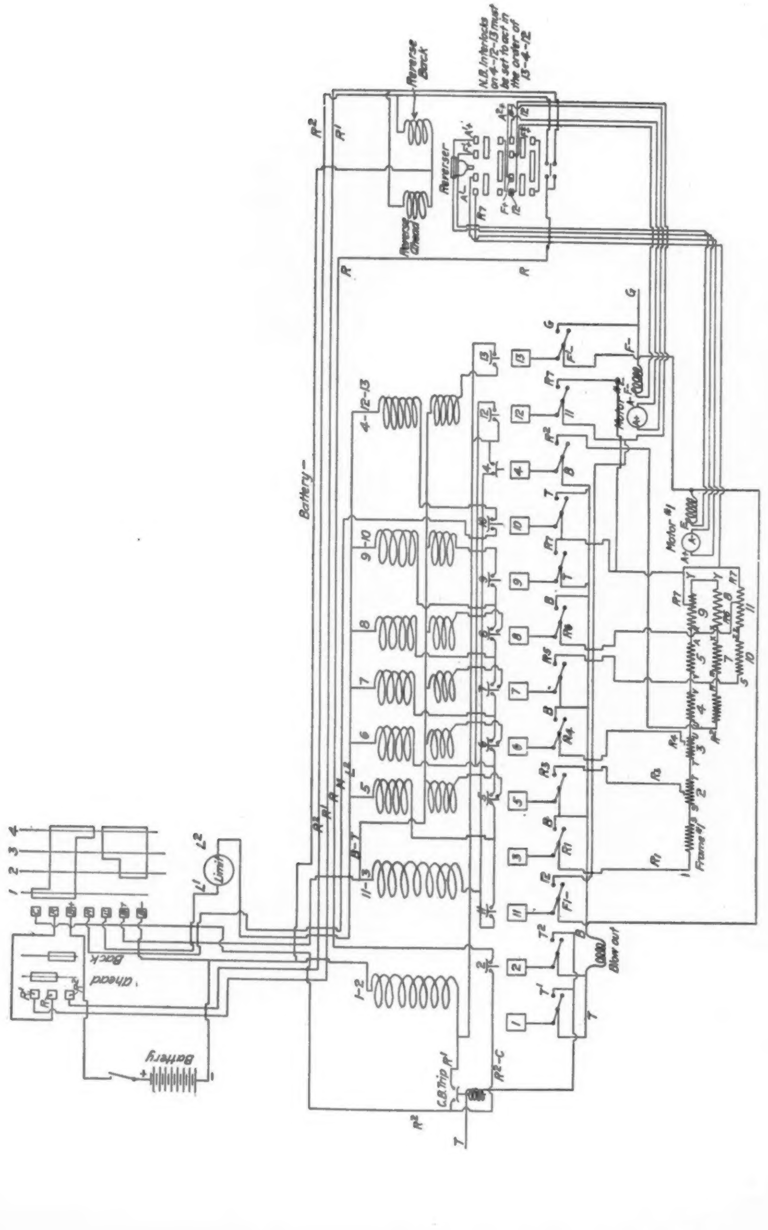


FIG. 9—WIRING DIAGRAM FOR ONE CAR.

notch of the master controller. Nos. 13-4-12 open switches 3 and 11, cutting out the series connections and throw the motors into multiple, then pick up the resistance controlled by 6, 7, 8 and 9, until the maximum speed is reached. The car being at rest, the movement of the master controller handle to the first notch from the "off" position closes the battery circuit through the reverser, moving that switch to the position controlled by the contacts made with reversing handle. This closes the circuit-breaker relay circuit and actuates the pistons 1 and 2 through to the coil shown above them, which movement closes the circuit-breaker. The next step closes the connection between rheostat R1, or maximum resistance and the motors, and at the same time makes the necessary series connections through 11 and 3. The third step cuts out the resistance by bringing switches 5 to 10 successively into play, each switch as it closes, closing the battery circuit for the next valve. Holding coils shown above each piston cut out the limit switch after each main switch has closed and prevent the limit switch releasing the contacts already made. The limit switch may be set to give any required acceleration and acts automatically in opening the battery circuit and preventing the pneumatic valves from opening too rapidly and burning out the motors with a sudden rush of current. The fourth step, or multiple position, closes switches 4, 12 and 13, and these in closing open 3 and 11 and establish a circuit through the holding coils of 6, 7, 8 and 9. The resistances controlled by these switches are then picked up in succession until maximum speed is reached.

The storage batteries used consist of two sets of seven cells each, type D-5 batteries of the Electric Storage Battery Company. They are enclosed in a box under the car and weigh, complete, 300 pounds. They are charged at night when the lamps are on, and either is sufficient to supply current for the day's run. All of the wiring in the car is enclosed in electro-asbestos conduits to guard against fire.—*The Railroad Gazette.*

Coal-Cutting by Machinery.*

In placing before the Manchester Geological and Mining Society the results of practical experience in the working of coal mines with mechanical coal-cutters, I cannot hope that this communication will rank in literary merit with the many excellent contributions of previous writers on the subject, addressed to this and kindred societies; but at least I feel that the information may be interesting and possibly useful, being the record of actual operations, under varying conditions, extending over a considerable period.

The subject is full of interest and of vital importance to the mining industry. It is likely to become more prominent in the immediate future, and as there are many difficulties and preiudices to be encountered and overcome, I believe it to be the duty of everyone, who can from experience add to the general knowledge thereof, to set forth to the best of his ability the information he has acquired.

THE ADOPTION OF THE MACHINE.

Some five years ago difficulties which had arisen in connection with the working of a seam at a colliery under my charge suggested the adoption of coal-cutting machines; with what amount of success the initial attempts were attended may be judged by the fact that we now have in regular operation 15 rotary machines and 14 percussive machines.

The application of the mechanical holing machines materially affects the working of coal seams, and the selection of a suitable machine for the purpose is of great importance. Such being the case, the machine must always be subject to the requirements and conditions of the mine, since the mine cannot always be modified or the conditions adjusted to suit the machine. At the same time the machine is only to be regarded as a substitute for the pick, and a more powerful and a more perfect implement, but like the pick in the sense that it requires skill and intelligence to use it, and in the fact that a good workman can obtain with it better results than a poor workman can be expected to show.

*** Paper by Mr. Owen Hughes, read before Manchester Geological and Mining Society, Manchester, England, April 21, 1903, with remarks on it made at this meeting.**

Perhaps many of the failures with coal-cutting machines are due to a want of recognition of these facts.

Difficulties are to be expected, and these we must overcome; and whilst the system of mechanical coal mining offers many advantages, it must be understood that it is not calculated to relieve the mining officials of any responsibility or make their lot more happy. It is not a case of mining made easy, nor will the introduction of the machine tend to lighten their duties. It rather tends to raise the standard and develop the intelligence of the colliery official. As to the machine operation, there can be but one result. Give a good workman a high-class tool and he himself becomes a better, a more skilful man, and in every sence a superior type of workman.

THE ADVANTAGES CLAIMED FOR MACHINE-CUTTING.

The advantages claimed for the systematic working of coal seams by mechanical coal-cutters are too well known to need mention here, but it may be said that experience teaches us that most, if not all, the claims have been fully realized, viz.:

1. An increase in the proportion of round coal.
2. Smaller loss in working (that is, a greater yield per acre).
3. In most mines a reduced working cost.
4. The necessity for explosives is reduced, in some mines amounting to entirely dispensing with shot firing, thus removing a great element of danger.
5. A larger output from a smaller area in a given time.
6. Reduced loss and cost of timber, together with fewer accidents from falls of roof.
7. A larger daily wage for the collier, whilst relieving him from the most dangerous and most laborious part of his work, viz., holing.

PREJUDICE OF THE MEN.

One of the first and often the most serious of the difficulties to be overcome in many cases is prejudice.

We have been singularly free from objection on the part of the men, and it may be interesting to explain how the first machine was introduced without arousing their opposition.

The first mine into which we introduced a machine was one of the following section:

Metal roof.

"Ley" 6 in. (which falls with the coal).

Coal, 2 ft. 9 in.

Fire clay, 1 ft. 2 in. (too hard for hand-holing).

Two mines below, in close proximity, had previously been worked leaving the upper seam hard, woody, and difficult to work by hand. The getting price paid to the collier was 3s. 6d. per ton, including allowances, but men could scarcely be induced to work in the seam even with the offer of increased allowance.

COMMENCING OPERATIONS ON A SMALL SCALE.

A machine of the Gillott's type was introduced. Operations were commenced on a limited scale. The "drawings" were reduced to the shortest possible distance, and the machine was commenced at the outset on a face only 25 yards in length. This necessitated a mere handful of men, one might say, to keep in good humor, and served as a training ground for the few employed.

At each succeeding cut the face extended and the number of men on the face was increased one or two at a time as required. In this way the operations developed gradually to the full extent, whereas had a start been made with a long face and with 80 or 100 men, it is more than probable some malcontent would have raised difficulties and unsettled the others, and to pacify the larger number would have proved a greater task than the education of a few men at a time.

Eventually the length of working face became 170 yards, across which the machine cut each night.

The coal holed by the machine at night time was dealt with by the colliers during the following day, and at the same time they prepared the face for the next cut.

During the second half-year after the commencement of this machine, it worked 145 days, or rather nights, and the amount of coal got by it was 14,278 tons, or an average of nearly 100 tons per day.

Encouraged by the success of the first attempt more machines were obtained and put to work in this and other mines

until at the present time we have about 30 machines of one type or another regularly working in the various seams. Two or three machines are also kept ready for work in the event of those in service getting out of order.

COMMENCING A CUT.

At this point it may be well to describe, generally, the system adopted with the machines and the preparation of the coal face.

I will describe a face with only one machine working, and cutting across from end to end.

To commence the cut we form, say at the extreme left of the coal face, what we call a chamber or stable; this is an opening into the coal as wide as the machine, and as deep or deeper than the wheel or cutter; where this is not done you will generally find the middle portion of the coal face in advance of the cutting ends, and the face gradually being worked into a curved line which is not desirable.

We find this plan preferable to that of commencing the cut by starting the machine at an angle with the face and gradually working the wheel under the coal, as can be done with some machines, for by commencing at one of these properly made stables the machine at once attacks the coal with a cut of full depth and proceeds across the face. It is also important that the machine should cut out and finish in the open, otherwise the machine wheel would remain under the coal, which might break and fall upon it, and also make it more difficult for the collier to get the coal out. For this purpose a chamber like the one at the commencement of the cut is made either by hand holing or a heading machine, and the machine cuts right through into this chamber, where it remains in readiness to commence the next cut across the face in the reverse direction.

TIMBERING.

The roof in the case of most of the mines referred to may be described either as bad or very bad. Timbering is carefully and systematically carried out; indeed this is an essential feature of the system of working.

Before the machine commences to cross the face and hole the coal, the roof is supported by bars set at right angles with the line of face. At one end the bars are notched into the coal, and at the other end are supported by props. The nearest row of props is set about 4 feet 6 inches from the face for a Gillott's machine, but with the Diamond machine, which is narrower, the distance bars need not be so great.

The props and bars are set 4 feet apart.

To each machine there are three men who are classed as first, second and third man. The duty of the first man is to superintend the front of the machine and to see that the rails have been properly laid by the third man, whose work it is to lay the rails in advance. The second man stops and starts the machine, and is called the "driver."

Behind the machine, as it progresses, the "driver" sets a prop under each bar about a foot from the face, since the under-cutting of the coal has weakened the support of the bar at the face. Sprags in the ordinary sense of the word are not used with machine-cutting, but wedges of timber are inserted in the cut at frequent intervals. Let me here point out the necessity of having a plentiful supply of props and wedges in each place for the use of the machine men, otherwise they will have to go in search of some and thus stop the progress of the machine.

GETTING AND FILLING THE COAL.

As a rule the holed coal breaks down and away from the roof, with little necessity for blasting, in large blocks with a cubical fracture, yielding good-sized cubical lumps, which find much favor with the customers, and the round coal is sounder and larger than that got by hand-holing.

The collier gets and fills the coal at a price which includes drawing the tubs to a maximum distance of 200 yards. He also during the process of removing the coal sets the props and bars as previously described, and prepares the face for the next cut.

YIELD OF LARGE COAL.

In the case of one seam 4 feet 4 inches thick the cost of machine-cutting leaves little or no margin as compared with hand-holing. For the latter the collier is paid 2s. 8d. per ton. By machine the collier receives 1s. 11¼d. per ton, and it costs 4¼d. per ton for cutting and cleaning out the holing, which amounts to

2s. 3½d., leaving only 4½d. per ton for power, maintenance, etc.

Detailed particulars of these items, and other costs, are given later on.

In such a case one expects the question: Where lies the advantage of machine-cutting?

It has already been mentioned that a reduction in the getting cost is not the only advantage, indeed it is not always the most important point, and in the case of the mine to which I refer there is an increase of 18% in the proportion of round coal which is equal to 10d. per ton increase in the selling price; this will, I think, justify the adoption of machines, even in the absence of other advantages. By hand-holing this mine yields 52% of round coal, then the face has to be stepped, owing to the difficulty of keeping up the roof with a straight face. With machine-holing the mine yields 70% of round coal. The face line is, of course, straight, and moves more quickly than the handworked face, thus the difficulty with the roof is overcome.

The stated proportion of round coal is that which passes over a mesh 1¼ in. square.

AVERAGE RESULTS OF WORKING.

The average results of working are set forth in detail in the following particulars which relate to tests recently made (under ordinary conditions) to ascertain the fuel consumption for machine cutting.

All the figures giving the weight of fuel consumed, etc., were very carefully ascertained for the purpose of this paper. In each case all other operations were stopped during the test, no steam being used for winding, pumping or hauling, so that the steam was used for air-compressing only.

No. 1 TEST, which lasted four hours.

Five Gillott's machines were working at this colliery; all were holing in the floor.

No. 1 machine worked three hours and cut 45 yards (the full extent of the face that happened to be ready). The depth of undercut was 2 feet 10 inches and the area of the cut, 42 square yards, yielding 38 tons; the mine being 2 feet 10 inches thick.

Nos. 2 and 3 machines were working in a newly opened mine in which the extent of face was limited for the reasons previously explained.

No. 2 worked two and a quarter hours and cut 42 yards.

No. 3 worked one and a quarter hours and cut 20 yards, or a total of 62 yards for both machines.

The coal is 2 feet 7 inches thick, the depth cut averaged 2 feet 11 inches and the area cut was 60 square yards, yielding 49 tons.

No. 4 machine worked four hours and cut 75 yards in length, and 3 feet under, or 75 square yards, yielding 102 tons; the mine being 4 feet 4 inches thick.

No. 5 machine cut 51 yards in four hours, 2 feet 11 inches deep in the same seam (4 feet 4 inches thick), and from a cut of 49 square yards produced 68 tons of coal.

The total yield of coal from the five machines was 257 tons.

The total area cut was 226 square yards.

	£	s.	d.
Weight of common slack consumed, 4 tons 3 cwts., at 4s. 6d. per ton	0	18	8
Stoker and engineman's wages one-third of a shift	0	2	8
	1	1	4

	d.
Cost per ton for fuel and wages to compress the air for the machines	0·99
Cost per superficial yard of holing for fuel and wages to compress the air required	1·13

To give the cost per ton only is not a satisfactory figure for comparison, as the tonnage result depends a great deal on the thickness of the seam, hence the reason for also giving the cost per square yard of undercut.

The compressed air was conveyed to a maximum distance of 750 yards, the nearest machine was 650 yards from the compressor.

No. 2 TEST, which lasted six hours.

A similar test was conducted at another colliery where four machines were at work. The following particulars show the results:

No. 1 machine worked six hours and cut 61 yards by 2 feet 10 inches deep, or an area of 57 square yards; and produced 36 tons of coal from a mine 2 feet thick.

No. 2 machine worked six hours in the same seam and cut 66 yards by 2 feet 10

inches deep, producing 39 tons of coal from an area of 62 square yards.

Both these machines were cutting in *very hard dirt*.

No. 3 machine worked three and half hours in a mine 3 feet 7 inches thick, and cut 57 yards by 2 feet 10 inches deep, or 53 square yards; the yield of coal was 61 tons.

No. 4 machine worked in a seam 3 feet 7 inches thick and cut 53 yards in four and quarter hours, 2 feet 10 inches deep = an area of 50 square yards, and produced 56 tons.

Nos. 3 and 4 machines cut as far as the face was ready, coal being down in the way.

The total yield of coal from this test was 192 tons.

The total area cut was 222 square yards.

	£	s.	d.
Weight of slack, commonly known as "Dant" consumed at the boilers was six tons, at 3s. 6d. per ton.	1	1	0
Stoker and engineman's wages, half shift..........	0	4	0
	1	5	0

	d.
Cost per ton for fuel and air-compressing	1·56
Cost per supl. yard for fuel and air-compressing	1·36

The maximum and minimum distances from the compressor to the machines were 2,000 yards and 700 yards, respectively. In all these cases the machines were working practically on the "end" of the coal.

The inclination of the mines is about 1 in 7.

The following particulars of cost refer to the getting of coal at the colliery where No. 1 test of fuel consumption was made. The figures relate to six months working with machines, and are compared with the cost of hand-holing.

Three machines of the Gillott's type were employed, one working in a mine 2 feet 10 inches thick, and two in a mine 4 feet 4 inches thick. The extent of face in the 4 feet 4 inches seam was 230 yards, and the advance of the face in six months was 110 yards (*i. e.*, 25,300 square yards of cutting). With hand-holing the face cutting). With hand-holing the face would only have advanced 40 yards during the same period.

The yield of coal from the three machines was 38,090 tons.

The cost of datalling work required in the ordinary drawing roads of these mines when worked by hand-holing is very great.

DETAILS OF COST PER TON.

	s.	d.
Cost per ton for cutting and clearing dirt from under the coal		4·25
Paid to collier for filling, timbering, cutting out, and drawing the tubs to a maximum distance of 200 yards.	1	11·50
Repairs to machine, including hose pipes, sharpening cutters and laying air-pipes =		·42
Cost of compressed air power as shown in No. 1 Test =		·99
	2	5·16

For hand-holing the payment to the collier was 2s. 8d. per ton, thus showing a saving in favor of the machines of nearly 3d. per ton.

To this must be added a gain of 10d. per ton in the selling price due to an increase from 52% to 70% of large coal, making a total gain of 1s. 1d. per ton.

The following particulars show the result of six months working at the colliery where No. 2 test of fuel consumption was made.

The mine in this case is 2 feet thick. The machines hole in the dirt under the coal, which is of a very hard nature.

Two Gillott's machines were worked on a face 200 yards long and during the last six months the face has advanced 90 yards. With hand-holing the face in this mine has advanced only 38 yards in the same time.

The yield of coal from the 18,000 square yards of cutting was 10,060 tons.

DETAILS OF COST PER TON.

	s.	d.
Cost of cutting and cleaning dirt from under the coal....	0	6·25
Paid to colliers for filling, timbering, cutting out and drawing the tubs up to 200 yards.	2	1·25
Repairs to machines, including hose pipes, sharpening cutters and laying pipes........	0	1·47
Cost of power (compressed air) as per No. 2 Test......	0	1·56
	2	10·53

The price paid to the collier was 3s. 10d. per ton; thus showing a saving of 11½d. per ton in favor of the machine; there was also a further gain of 9½d. per ton in the selling price, due to an increase in the proportion of round coal from 43 per cent. to 58 per cent., or a total gain of 1s. 9d. per ton.

The higher cost per ton for repairs, etc., in this case is to be explained by the fact of the holing being very hard, and the mine thin, yielding a lower tonnage for each superficial yard of cut.

In neither of these cases have I taken into account the cost of plant or depreciation. The power plant is used for other purposes, and it is difficult to correctly apportion the share which should be borne by the coal-cutting operations.

THE IMPORTANCE OF ADAPTING THE MACHINE TO THE MINE.

Earlier in my remarks I ventured to point out that a machine which gave excellent results in one mine might prove a failure in another. In other words, each mine must be separately studied and a suitable type of machine introduced to meet the particular requirements.

As an instance I may quote the case of a mine of hard coal, 4 feet 6 inches thick, with 12 inches of "ley" which came down with the coal.

A Gillott's machine was first put to work on a face 90 yards long.

The price paid for hand-holing, including the removal of the ley, was 2s. 8d. per ton, the coal being worked on the face. The Gillott machine worked on the end and holed about 2 feet 10 inches under the coal. Shots of 3 oz. had to be put in every 2½ or 3 yards apart to break the coal down, and this, together with the large amount of pick work necessary, gave no advantage as regards the proportion of round and small which remained the same, viz.: 50 per cent. of each, and the cost was about the same as for hand-holing.

The Gillott machine was therefore deemed unsuitable for this mine, and a Diamond machine cutting 4 feet 6 inches under the coal was introduced. The results were remarkable, the proportion of round coal was increased by 22 per cent. Instead of shots being fired as stated, only one 3-oz. charge was required every 20 or 30 yards, and sometimes no blasting was necessary.

The saving in cost per ton was as follows:

	Hand worked.		Gillot's machine.		Diamond machine.	
	s.	d.	s.	d.	s.	d.
Cost for cutting and clearing the dirt from under the coal	......		0	4·25	0	4·0
Paid to collier for filling, timbering, cutting out and packing the "ley" and drawing the tubs up to 200 yards	2	8	2	3·50	1	8·0
Power, say	...	..	0	1·00	0	1·0
	2	8	2	8·75	2	1·0

The saving in favor of the Diamond machine was nearly 7¾d. per ton, to which must be added 1s. 0½d. per ton increased selling price, due to an increase from 50 to 72% of round coal, making a total gain of 1s. 8¼d. per ton.

It should be explained that in this particular case a block of coal was being worked out which had been left in the midst of old works and pillars for more than 20 years.

During the time occupied, rather under 12 months, no repairs were necessary to the machines. The sharpening was done by the smiths, together with the colliers' picks, and no separate record was kept. The pipe-laying was done by the machine men.

In another mine 3 feet 6 inches thick, two machines recently started are now working on the "end" of the coal. One machine is a Gillott, the other a Diamond. The underclay is too hard to hole in so that both machines hole in the coal, which sticks to the roof and the floor. The Gillott machine leaves three or four inches of bottom coal which has to be got up with the pick, and the cut is not deep enough to cause the coal to break away from the roof, consequently there is a lot of pick work, the proportion of small coal is high and the cost is nearly the same as for hand-holing.

The Diamond machine, on the other hand, cuts to the floor level, and leaves no "bottoms" on, whilst the deeper cut (4 feet 6 inches) causes the coal to break away naturally in large blocks. No explosives have been used in this mine for coal getting, and with the latter machine the necessity for blasting would almost appear to be removed.

The comparative costs per ton are as follows:

	Hand worked.	Gillott machine.	Diamond machine.
	s. d.	s. d.	s. d.
Cost of cutting	......	0 3·25	0 2·25
Paid to collier for filling, cutting out, timbering, and drawing the tubs up to 200 yards	2 4·5	1 11	1 3
Repairs to machines, sharpening, etc., not taken into account in either case	......	......	......
Fuel and wages for power, as per test No. 1	......	0 0 99	0 0·99
	2 4·5	2 3·24	1 6·24

The saving in favor of the Diamond machine is 9d. per ton. The increase of round coal from 50 to 74% is equal to 1s. per ton on the selling price; the total gain in favor of the Diamond machine is 1s. 9d. per ton.

PERCUSSIVE MACHINES.

Hitherto I have referred only to machines suitable for longwall faces; our application of mechanical coal-cutters, however, also includes machines of the percussive type, usually described as mechanical picks.

For certain purposes we have found these to be most useful appliances. Of course, they cannot compare with the disc machines in longwall working, nor are they intended for that purpose. We have employed the Ingersoll-Sergeant and the Champion machines for heading out purposes. Both are perhaps capable of further improvement, but they have good points, and the results with them are very encouraging.

The Ingersoll can be transported from place to place intact. It requires considerable skill to work it to the best advantage, but when the knack of working it properly is acquired a good man can undercut with one machine an average of four places, each 10 or 12 feet wide and 3½ feet deep, in a shift of nine hours (including meal times), and also flit the machine from place to place, provided the headings are not too far apart.

The Ingersoll makes a cut something like that made in hand holing, *i. e.*, high at the front and tapering out at the back of the cut, so that the proportion of small coal is not appreciably reduced when holing in the coal; but these machines will hole in the underclay, which would be too hard for hand-holing.

The Champion machine, on the other hand, is capable of doing an equal amount of work and of making a parallel cut of a uniform height of only about three inches in any desired position, and is equally applicable to flat or steep seams. We have found it a very handy and useful machine. It is not difficult to transport it, but if it could be designed for removal without the necessity of taking it to pieces it would be a great improvement.

A great advantage with this machine is the fact that it is easily learned, and manipulated at less cost than some other heading machines. With it a seam would yield a larger percentage of round coal, and when fixed a lad can work it.

There is a difficulty in working the Ingersoll in steep seams; but, on the other hand, it can be employed to advantage in thick seams where there *might* be a difficulty in applying the Champion machine owing to the extra length of standard required.

We have found both machines very useful in cutting the necessary strait work through the shaft pillar, and also in driving to the boundary in the case of a mine which is to be worked by means of disc machines on the system known as "longwall retreating."

We have a seam 2 feet 8 inches thick which is too costly to work on the pillar and stall method, the field rate for strait work being 6s. per ton. On the other hand a very bad roof makes longwall working very costly, on account of the expense of maintaining pack roads. In these circumstances four Ingersoll machines were introduced to cut out to the boundary. The levels through the solid coal are 35 yards apart, with cut-throughs only, as required for ventilation. These levels are to be carried out to the boundary, and the intention is, when the boundary is reached, to work the coal out by a retreating longwall face with disc machines.

The cost of driving the levels with the Ingersoll machine is:

	s.	d.	
Collier for getting the coal down, filling and drawing the tubs............	2	3	per ton.
Cutting	1	0	"
	3	3	per ton.

as against 6s. per ton by hand.

The places are 12 feet wide and 9 inches of ley is got down by the collier, after which the roads stand without further expense.

We also have a seam of the following section, viz.:

	ft.	in.
Coal	1	8
Very hard dirt parting	2	5
Coal	2	4

A down brow was being driven where water proved very troublesome. It was very costly working by hand, and not more than two yards per week was driven. An Ingersoll machine was put to work, which holed in the middle dirt on the top of the bottom coal; four yards of this coal was always left on to keep the water back. By this means the brow was driven 10 to 12 yards per week.

The places are, of course, driven in considerably less time than would be possible by hand-cutting.

These punching machines require an air pressure of from 50 to 70 pounds per square inch. The higher the pressure the better results will be obtained from the machines.

To facilitate the working of either of these punching machines it is important that the necessary platform for the Ingersoll, and the packing pieces for the Champion machine should be provided in each working place.

General Remarks.

POWER.

The working of coal-cutting machines is, of course, a case of power transmission. My own experience relates to compressed air power only. I have no personal experience of electricity for this particular purpose.

I am anxious that the fact of all the coal-cutting machines at the collieries referred to being operated by compressed air shall not be interpreted as an indication of any want of confidence on my part in electrical energy. I believe that good results are being obtained by electrically driven machines.

It is with regard to compressed air that I have to speak, and I would here call attention to several details which enabled certain difficulties to be overcome. It is remarkable how largely the operations are affected by what are apparently minor details. It is to be feared that in many cases where the operations have been unsuccessful, the real cause of failure has been some minor detail which has perhaps not had sufficient attention, or has probably escaped notice altogether.

In working a coal-cutting machine it is necessary to provide ample power. The load is most variable and difficult to estimate.

Pipes conveying the air are often too small, necessitating a high velocity of the air, which means great loss of power in frictional resistance, and a low pressure at the machines. Often the initial pressure of the air is too low; it should never be below 50 lbs., and 60 lbs. is better, although not by any means too high.

We usually put in pipes of the following dimensions, viz., pipes of 5 square inches area up the gateways for supplying one machine, but this size of pipe should not be longer than 150 yards. The pipes from the bottom of the gateways to the bottom of the pit shaft, if not too great a distance, should not be less than 7 square inches area, and pipes of a rather larger area from the compressor and down the shaft. The area of the pipes should be increased in proportion to the number of rotary machines intended to work off them.

Difficulties are sometimes experienced with ice forming in the exhaust ports of the machine. This is an inherent trouble with compressed air motors, but the trouble may be reduced to a minimum. We have succeeded in overcoming the difficulty in rather a simple way. As near to the machine as may be convenient we place a receiver—a cast-iron pipe of 18 inches to 2 feet diameter × feet long. The inlet air enters at one end of the receiver. The opposite end is closed. The outlet pipe leading to the machine is connected to the receiver *at the top near the other end.* This has the effect of deflecting the air and of separating from it a large portion of the moisture, which is thrown down and collects at the bottom of the receiver, from which it can be drained from time to time by means of a tap. Whether this is a true explanation or not, it is a fact that since the adoption of these receivers, with the outlet pipes at right angles with the inlet pipes, we have had no trouble with freezing either at the coal-cutting machines or hauling engines.

The flexible hose used for coupling up from the machines to the air pipes is

rather expensive and should be taken great care of, and put out of the way when not actually in use. The iron or steel pipes should be extended from time to time, and so arranged as to enable the machine to be connected with not more than four 30 feet lengths of hose, service taps being provided on the pipe line every 40 or 50 yards for the purpose.

Pipes with screwed joints are not to be recommended, nor are spigot or faucet joints. Flanged pipes which can be coupled together at either end, with joints such as the Acme and the Eadie joints, are generally to be preferred as being more easily handled.

Pipes conveying compressed air should be so fixed that the joints are visible so as to detect any leakage; and out of the way so that the flanges cannot be damaged either by a fall of roof or a passing tub.

DUST AND NOISE.

A great objection to air-driven machines is the great noise of the exhaust and the clouds of choking dust in a dry mine. The exhaust in the Gillott and certain other machines blows directly on to the floor. The best remedy for this is a baffle plate of sheet-iron fixed under the exhaust which not only deadens the noise to some extent but overcomes the difficulty from dust almost entirely and keeps the bearings of the machine clean and cool.

TYPES OF DISC MACHINES USED.

The Gillott machine is the one we have used more extensively up to the present, but the Diamond machine possesses a number of important features which greatly enhance its value, and, as I have shown, it gives better results under certain conditions.

The Diamond machine does not take up so much space in width, but on the other hand it is somewhat longer than the Gillott, and whilst it permits the row of props being set nearer the face, it is not always so easy to handle, where its extra length might take up too much room. The Diamond can *also* be made to cut actually on the floor level. The several sizes of this machine cutting from 3 feet to 6 or 7 feet in depth renders it more adaptable to varying conditions. The simple mode of attaching the cutters is excellent.

I should also say, that, where a depth of undercut not exceeding 3 feet is sufficient, the Gillott is a very handy machine.

I should like to mention here that I do not believe all mines can be successfully and profitably worked by machines. We have more than one seam where I feel sure the introduction of machines would prove a failure.

SAVING OF TIMBER.

It has been mentioned that one of the advantages of machine cutting is the reduced cost of timber.

This is not because a smaller quantity of timber is actually in use, but rather because the amount of lost and broken timber is less.

With hand-holing and a slowly advancing face, the weight comes on and breaks the timber. With machine-mining the faces move so quickly that the timber can be withdrawn and reset before much of it is called upon to carry any great weight.

REPAIRS.

With regard to repairs, when a machine seriously breaks down, we find the best plan is to send it up the pit to be thoroughly overhauled and put in good working order before it is allowed to be put to work again. In the meantime, one of the reserve machines will have been brought into operation.

The plan of tinkering at a disabled machine in the mine is not to be recommended; no doubt a machine can be patched up to continue working for a short time, but sooner or later it will break down again and cause delay, and the last state of the machine will be worse than the first.

SPEED OF CUTTING.

By way of showing what is possible with coal-cutting machines, on one occasion we made preparations for a special test with a Gillott's machine.

To give a quicker rate of advance the usual propelling gear was modified. The hauling rope, instead of being passed round a pulley attached to a prop ahead of the machine and brought back to the drawbar of the machine, was paid out singly for a distance of nearly 70 yards and secured to a prop. This gave not only a greater length of travel without having to stop to readjust the hauling rope, but also doubled the usual speed of travel.

Every facility was given for straightforward cutting, and the rails were laid well in advance of the machine.

The distance cut along the face was 65 yards, the depth of cut 2 feet 10 inches, and the time occupied 67 minutes.

Of course, this was a special test, and does not represent the usual rate of cutting, but it shows what is possible for a short time under very favorable conditions.

THE MINE OFFICIALS AND THE MACHINES.

For the successful working of coal-cutting machines it is very desirable, indeed it is most essential, that the mine officials, although not themselves operating the machines, should be capable of doing so if occasion should arise. At least they should be quite familiar with the details of the machine and its operation, otherwise it is possible some machine men may be inclined to impose upon them and give all manner of excuses to account for slow progress or unsatisfactory work.

Some machine men will not hesitate to take advantage of the inexperience of the officials, as the following instance will show.

In one of our collieries a machine had already been introduced before my employers took it over. The machine had only worked intermittently and with indifferent results. The men alleged that the machine constantly broke down, and although the face was only 70 yards in length they only occasionally cut across it in 14 hours. We changed the officials; the new under-manager, a man who knew a coal-cutter when he saw one, personally superintended a cut. Operations were commenced at 5.30 P. M., and at 9.30, four hours later, completed the 70 yards. The men recognized the new intelligence, and afterward breakdowns and stoppages were few, whilst additional machines were introduced.

In conclusion, I will give another source of trouble at one of our collieries which was alleged to be a want of air pressure. The machines were not giving good results and were making slow progress. The engineman insisted that the pressure had been kept up all night. An automatic pressure recorder was fixed, to make a chart showing the exact pressure of the air at any moment during the 24 hours. In the face of the indisputable evidence of this instrument the men recognized the futility of their old excuse, and there were fewer complaints of want of air pressure.

The President said: "I feel sure the Society is to be congratulated on the fact of having had a paper on coal-cutting from Mr. Hughes. He has more coal-cutting machines at work than any one else in this part of the world, and he was really the right man to give us a paper on the subject. I am sure we shall all be agreed that the paper, if not the best written on the subject, comes very near being so. So far as I can judge it is full of practical information, and put in a way that mine managers can understand. He has not been shy in giving us the cost. In some quarters there is a shyness in regard to matters of cost of machines in comparison with the cost of labor."

Mr. Smethurst moved a vote of thanks to Mr. Hughes for his valuable communication.

Mr. R. Winstanley said he had pleasure in seconding the motion to Mr. Hughes, who had passed several years at collieries under his own supervision. He was consequently proud to know that Mr. Hughes had followed up his early training and paid such attention to the subject of machine coal-cutting, as was revealed by his paper.

The motion was cordially approved.

Mr. Garforth—I think the paper is one of the best I have ever listened to, and I endorse all that the President and others have said in its praise. I am rather surprised at some of the figures given by Mr. Hughes. They are better than I expected; but, as he says, every seam requires different treatment, so that a machine while suitable in one seam may be a failure in another. In one of the mines which I am associated with we have a large quantity of work done by machines. Out of a total output of 553,000 tons, 420,000 tons were cut by machinery, and I am glad to say we are raising over 1,000 tons a day as the product of machines in one seam of coal which has been at work for nearly four years without a single accident occurring at the coal-face. Immunity from accident is a matter which I should like to see referred to by Mr. Hughes. The advantages which we gain as regards safety and freedom from accident are, I think, the most pleasing features con-

nected with coal-cutting. But there are many interesting points connected with the introduction of machinery which will lead to a more scientific system of mining. A straight line of cut produces a straight line of fracture, and that leads to a straight line of timbering, which I believe will overcome many of the difficulties now met with in attempting to introduce systematic timbering. That is a large question, but if at some future time you would like to see 50 or 60 photographs I have had taken in connection with this subject, and which may help in this discussion, I need not say with what pleasure I shall have them brought here. I have only to congratulate Mr. Hughes once more on his very good and practical paper.

Mr. Gerrard—May we take that as an offer?

Mr. Garforth—Yes; I may add that judging by the fact that the photographs have been exhibited on two different occasions by request, members will understand they may be of service to those who have not had much experience in coal-cutting.

Mr. Dury Mitton—I have listened with very great interest to Mr. Hughes's paper. I made a few notes of pertinent things to ask questions about, but Mr. Hughes has forestalled me by answering, in his paper, the points I thought of, which shows how fully he has covered the ground. I was rather surprised, as the last speaker said, at some of the figures. In regard to the increase in the yield of coal, I should like to know how Mr. Hughes arrives at his percentage—whether he took the whole of the coal coming out of the mine or not. His figure seems to me rather high. He does not mention anything about depreciation for coal-cutters in his comparison between the cost of hand labor and machine work. I think that should be taken into consideration for there is a large amount of wear and tear. He gives so much for repairs, but the amount he mentions is very low, when you come to think that they do wear out and have such a heavy strain to bear. A few weeks ago I was watching two coal-cutters at work in a 3-foot mine with very hard stone underneath, and it struck me that the Diamond machine was the most successful. It was undercutting between 60 and 70 lineal yards a shift, and there was no trouble with it; but the other was working very unsatisfactorily, namely, the Morgan-Gardner machine. It struck me that with a rotary machine we seem to get more power than with a chain machine. I was also impressed with the immense amount of sparking given out by the Morgan-Gardner machine, whether that was due to the fact that the power was not directly applied at the end of the holing or not I cannot say, but if the sparking resulted from that fact it certainly was unfavorable to that machine which was only cutting about 30 yards in one shift. That was the only experience I had had of the Morgan-Gardner. It would be interesting to hear further on this point as the sparking from the cutters is a danger. I should like to ask Mr. Hughes as to the pressure of air he has on his rotary machine.

Mr. Burrows said there was everything in favor if the deep cut if the coal could be filled out quickly. He wished to know if Mr. Hughes made a point of clearing the coal out each day.

Mr. Pilkington asked if Mr. Hughes could say which was the best machine to use when a steep mine had to be dealt with. The dip of his mine was 1 in 3½, and he had three kinds of machines at work. The machines had not been working long enough for him to be able to come to a definite conclusion.

Mr. Percy Wood said his experience had been that the Gillott machine holed too deep, and he was much surprised one night while watching it cutting, perhaps, four or five yards. As it cut along there was not a spade full of coal obtained from the machine. The coal dropped down, and practically every particle of it was removed by the machine, being ground up to dust and mixed with the dirt in which the machine was cutting. They had therefore to stop the machine because it was cutting too deep, and that was principally on account of the machine working along the line of the cleavage in the coal. Probably it would be better if it was worked across the line of "shut." As to the cost of repairs, his experience had been very different from that of Mr. Hughes. They had one machine, and after working two months it had to be brought out of the pit and, practically, they had to repair a good half of the machine.

If necessary repairs went on at that rate the machine would be worn out in twelve months.

Mr. Hughes, in replying, said the pressure of air was from 50 to 60 lbs. per square inch at the compressors. He knew of a Gillott machine which had been working for 12 years, and he was informed that it was in as good condition now as it was six or seven years ago. The stated percentages of slack made by the machines and by hand-holing, were the results of special tests which were made periodically. With regard to Mr. Burrows's question in the case of the mine, 4 feet 6 inches thick, he thought that for six months a day never passed without the loose coal being cleared from the face; the drawing roads were made 20 yards apart, with a temporary, or what was sometimes called a blind road, between these, but in another case where the coal face was 250 yards long and there was only one machine to do the work with which they had not been able to clear the coal out every shift. Of course, it was intended to put more machines in. If we had a machine making a cut, say 4 feet deep, and sufficient machines to cut across the face each day, it would help to get the coal out sooner if the drawing roads were arranged as already stated. It was also advisable to have the drawing roads near each end of the face closer together to enable the coal to be cleared out quickly so as to allow the machine to be put to work at the proper time. As to there being any difficulty in timbering in conjunction with the deeper cut, his experience showed that the roof could be controlled much easier. He had had no experience of machines working in steep mines, so could not say which form of machine was the best for working them. In reply to Mr. Wood, if the coal came over on the machine when working on the face of the coal, the difficulty might be remedied by putting the machine on "half end." If that would not answer he would put it to work on the "end" of the coal, and if not satisfactory then he would take the machine out of the mine. In regard to repairs it was expensive to send fitters down the pit to repair machinery. If the necessary repairs were so extensive that the man in charge of the machine could not put them right, he found it was much cheaper to take the machine out of the mine to the fitter. A great deal depended on the care taken of the machines by the machine men. On more than one occasion men had been discharged because of the frequent repairs that their machines required.

The President suggested that the meeting had perhaps lasted long enough, and that it would be well to defer further discussion until the paper had been printed and placed in the hands of members. With regard to the question of financial gain, he wondered how it was that coal-cutting machines were not used in every mine if the gain was, as Mr. Hughes said it was in his case, from 10d. to 1s. 9d. a ton. Tenpence would be a handsome profit, but 1s. 9d. was very great. He was not certain that in considering the machines they were quite fair. There was the point about the increased quantity of round coal. In a large number of cases the increased quantity of round came from the fact that the machine holed in dirt and the man in coal. He wanted to know whether the machine could hole in dirt that a man could not hole in. He knew it was usual for the collier to hole in coal, but it was a matter of custom, and he did not think it fair to give all the advantage to the machine cutter. There were many mines in which if the men were willing they could hole in the dirt, and if the masters were willing to give them threepence a ton more probably they would gain this additional advantage of round coal. Then they did not take into account the quality of the slack. That which the machine made was almost worthless, but the slack which the man made was not so. Two-thirds of it would make "nuts." Of course, machines made less of it. As to sparks, there seemed to be some doubt whether sparks would light gas or not. He had occasion to make a test the other day, in connection with an explosion which could not be accounted for. One person said it was caused by sparks. He took the man who held that view to a colliery where there was some gas coming up a pipe from the workings below. Bunches of sparks were produced by striking a steel pick against ironstone, but they did not succeed in lighting the gas. Afterward they lighted household gas quite readily by the same means. He had never been satisfied that sparks, ordinary sparks—

he was not speaking of electric sparks—would light gas in mines, and hence he did not think they had much to fear from coal-cutters striking sparks on pyrites or anything of that kind. One point which he thought was in favor of machines—was that by their means it seemed possible to do away with the blasting of the coal almost entirely. He understood that Tonge's Hydraulic Cartridge had been found to be quite capable of getting the coal after it had been well holed by a machine coal-cutter.

Mr. Garforth—As to sparks produced in the process of holing I do not remember a case during thirty years where they have caused an explosion. Gas lies near the roof, the cutting is generally done near the floor, producing a certain amount of dust, which smothers the sparks that are given off. As regards electric sparks produced at the brushes or commutator, I have made some experiments with enclosed electric motors in a highly explosive mixture in a specially constructed chamber on the surface. I used a mixture consisting of 10 per cent. of manufactured gas and 90 per cent. of air. In six recorded experiments we have not had a single mishap with the enclosed electric motors, while in every case with open type electric motors we have been able to ignite the gas surrounding the machine.

Mr. Dickinson—Now and then one sees a spark of greater intensity than ordinary sparks, and also there is the difficulty in the fire damp varying in proportion to the mixture of air, and also in the purity of the gas which sometimes makes it more highly explosive.

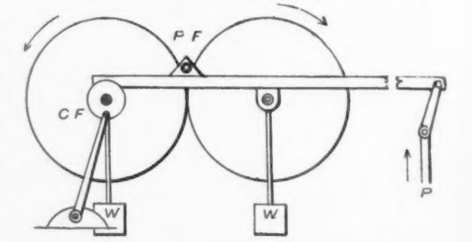
Mr. Tonge, referring to the President's remarks on the lighting of gas in mines by ordinary sparks, and also to Mr. Dickinson's saying there were varying proportions of air and firedamp, and also in the purity of the gas, "which sometimes makes it more highly explosive," said he would like also to point out the fact that there was occasionally a certain percentage of carbonic oxide (carbon monoxide) present with the carburretted hydrogen; and as this gas ignites at a temperature of 1184° F., which is more than 400 degrees Fahrenheit below the ignition point of firedamp, there can be little doubt but that this is sometimes the cause of gas being fired unexpectedly.

A New Air Compressor.

In a recent issue of the *Engineer*, W. E. Fish, of Kirksville, Mo., writes of a new air compressor which has recently been invented by a man in his town. Through the courtesy of the *Engineer* we are able to publish this article with the original illustrations.

Mr. Fish's contribution is as follows:

"In this machine, the inventor, Mr. C. J. Pollock, of Kirksville, Mo., has ap-



FIGS. 1, 2 AND 3.

plied the force of gravity and the principal of levers in a very ingenious way.

"The figures show the principles upon which the machine works. It is a series of compound levers. The crank is a revolving leverage with the crankpin as a shifting fulcrum. Fig. 1 is, as it stands, ready to start on the upward stroke; power is applied by a steam cylinder

at P, the end of the oscillating frame. Fig. 2 is the position at the top of the stroke with weights, W W, ready to start downward by gravity.

"Fig. 3 is at one-half stroke downward: As the crank-fulcrum, C F, nears the bottom centre it acts as a toggle-joint, giving tremendous force at the end of the stroke, so that the energy stored in the radial weights, W W, is used when most needed.

"Being the first design, and built in a small shop without the aid of a draughtsman, the compressor is a very crude, awkward looking affair and not well proportioned, but it has given some interesting results. It is 80 feet from the boiler, which carries a steam pressure of

FIG. 4—THE AIR COMPRESSOR.

65 pounds, supplied through 50 feet of 1¼ inch bare pipe. The steam cylinder is 4⅞ by 28 inches, and steam is cut off at 16 inches, and exhausted at 24 inches; 4 inches not being used by reason of the angle of the oscillating frame. The weights having been raised, fall by gravity, compressing the air in a cylinder 5 9-16 by 24 inches (one-fourth larger in area than the steam cylinder) into a receiver at 140 pounds pressure. By reason of the fulcrum at the crank continuously growing shorter, the power increases as the piston descends, giving a maximum at the end of the stroke, just where it is needed. The air compressor runs with this load at 60 revolutions per minute. The design has been very much improved since the first machine was built, making it more compact."

Working Granite with Compressed Air Tools.

An industry in which pneumatic tools bid fair to effect a revolution is the working of granite. Up till a few years ago the granite tombstones which are to be seen in every cemetery, and the elaborately carved granite blocks which are now so popular for the fronts of banks and public houses, were dressed by hand with a hammer and chisel in much the same way as we may suppose the Egyptians carved the Sphinx. Now a jet of air is doing the mason's work, and instead of expending much time and muscle on his task the workman has simply to guide the pneumatic chisel over the surface of the stone. The saving in manual labor is very great. The work is done more rapidly and more cheaply by these tools than by hand, and it might also be said more efficiently, for a pneumatic chisel can be operated in recesses and out-of-the-way places in which there would not be room to strike a blow with an ordinary hammer.

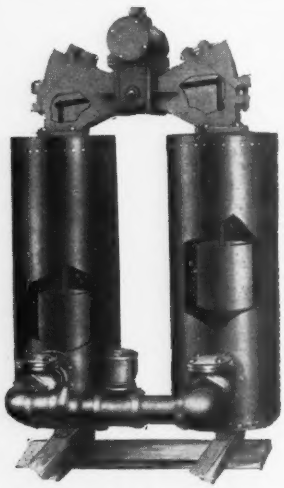
Aberdeen is the centre of the granite industry in Great Britain, and there is no granite working establishment there of any consequence which has not an equipment of pneumatic tools. The heart of a pneumatic plant is the compressor, or pump, which forces the air into a large tank or reservoir. From this central point the air is conveyed in pipes to all parts of the works, and the connection with the actual tools is made with a length of india rubber hose so that the workman can move the apparatus from place to place.

Where a workman would have had a hammer and a chisel in his hands, now he has a pneumatic chisel, and he has simply to direct it in the required position. The number of blows that a tool like this strikes is marvelous. The jet of compressed air operates a piston, to which either a hammer or a chisel can be attached, and the admission of the air can be so regulated by valves as to give anything from 2,000 to 15,000 strokes a minute. As might be supposed, the vibration caused by such a rapid movement as this is very great. A visitor to

a granite yard is generally given one of these pneumatic tools to hold, and unless he grips it tight it is apt to jump out of his hand. One could think that the constant use of such tools would injure the workman's arms and lead to cramp. So far, however, there have been no instances of this.—*London Sphere.*

Displacement Pump.

Simple in construction is the new displacement pump illustrated herewith which the Latta & Martin Pump Co. of Hickory, N. C., has placed on the market. A valve at the top of the pump is so constructed that compressed air can enter



DISPLACEMENT PUMP.

only one cylinder at a time and the air so entering forces the water from the cylinder by displacement. When all the water is expelled from that cylinder, the small copper bucket in the same, being unsupported by the expelled water, operates as a weight, and by pulling down the small lever in the valve, actuates a trip for releasing the exhausted air, and at the same time turning the compressed air into the other cylinder where the same operation is repeated. It is claimed that with this system water can be pumped from any distance against any elevation and in any quantity, the operation of the entire system being at the same time controlled at will by the engineer in the boiler, engine or power room, wherever located irrespective of the location of the water supply.

The Combined Straight-air and Automatic Engine and Tender Brake.*

With the advent of the modern powerful freight engine a new condition in train braking arises, a condition heretofore comparatively unknown, viz., stopping long trains without breaking in two. If the brake is held on until the train comes to a full stop, this danger is eliminated, but the trouble is in enforcing the rule governing this feature. A close personal check of the causes of break-in-twos where long trains are handled with heavy power showed that 78 per cent. were due to releasing at slow speeds.

On our division of less than 120 miles the usual number of break-in-twos monthly run from 40 to 48, or an average of 44 per month. Seventy-eight per cent. of this équals 34.32. Of these about 20 per cent. were broken couplers, requiring renewal. About 45 per cent. were broken knuckles, the remainder being due to other causes. The cost for renewal of these broken couplers and knuckles, less "credits," would equal $84.56 monthly, or $1,014.72 annually. But the cost of labor and material for break-in-twos is but a small proportion of the actual cost. When the cost of detentions and train delays and frequent damage either to equipment or to lading on account of trains parting and running together are considered we can readily see the necessity for some device that will aid in chĕcking this evil. The last Car Foremen's Association report gives us a cause of trains parting: "Release of brakes at slow speed without proper resistance on the engine or head-end cars." Among the recommendations made to overcome this evil is the following:

"We would recommend that all engines in road service be equipped with straight-air; or if this does not meet with the approval of the officials, it would be necessary for the superintend-

*Extracts made by the *Railroad Gazette* of a paper read before the Traveling Engineers' Association by Frank P. Roesch, of the Chicago & Alton R. R.

ent to issue bulletins to trainmen requiring that where slow-downs are made, where the speed is not to exceed 8 m.p.h., that the train be brought to a full stop, or have the trainmen set up about six retainers on the head end of the train or set at least from four to six hand brakes. The application of straight-air on the locomotive, however, is the best method of overcoming break-in-twos from this cause."

With the increase in locomotive power, the train length has increased proportionately, and as the brakes release on the head end first, the increased train length allows the full release on the head end of the train while the rear brakes are still set. This causes the surge and damage when brakes are released at slow speeds.

Another new phase in railroading due entirely to increased power and the demand for quick movement is the increase in size and power of yard and switch engines. The larger types of freight engines hauling such immense trains into the yards required a proportionate increase in capacity of yard engines to handle these trains. This necessitated a more efficient brake to handle these trains expeditiously, as with the present or automatic brake it was soon noticed that the repeated heavy reductions required gave insufficient time for recharging, thus reducing the holding power of the brake and causing the engineer to put more dependence in his reverse lever than in his driver brake, naturally resulting in a slower movement and greater damage, not only to his engine, but to equipment and lading as well. It was in the train yard that the first demand was made for a more flexible brake and it was ably met in the new combined automatic and straight-air brake.

In order to ascertain the extent of its use at present and the success it has met with, a list of questions was sent to members. Twelve roads reported having the device in use.

In regard to the cost of maintenance over the plain automatic brake, the replies from members having used the device for periods of from six to eighteen months show that the cost for repairs as yet has been nil.

Other advantages not spoken of previously are as follows:

1. It quickens switching and reduces the incident damage to lading and equipment. It has been estimated that the time saved by a yard engine equipped with this device over one equipped with the ordinary automatic brake, if expressed in dollars and cents equivalent to wages of crew, is about $1.25 per day. At this figure it would pay for itself in one month.

2. If the brakes are released on long trains, it prevents the slack from running out and the train from separating, especially at low speeds.

3. It prevents the slack of long trains from running in or out so suddenly, by reason of change of grade (sags or humps) or curvature, as to cause serious shocks and breaking in two.

4. It can be used to slow down or stop trains where the brake work required is not heavy, thus reducing pump labor, stuck brakes, wheel sliding and the breaking in two, incident to starting long trains with the brake-shoes dragging, or sometimes brakes stuck on cars toward the rear of train—a not uncommon result with automatic held on until the stop is made.

5. It prevents the slack from running out and aids the car retainers in controlling speed while descending heavy grades.

6. It holds the train and engine and enables the automatic brakes to be recharged when standing on grades, thus having the train brakes ready for immediate use at the start. It increases the safety when work requires that someone go under the engine, rendering it impossible for the engine brake to leak off. The latter prevents the possibility of the engine getting away when no one is present, even though the throttle leaks.

7. It enables control of speed while weighing cars.

8. It increases the mileage between tire turning, where tire-dressing shoes are used.

9. It decreases repairs to the automatic brake valve and the foundation rigging by reducing the use of the brake valve in emergency applications, something practiced by hostlers and yard enginemen everywhere.

The only disadvantage, if it can reasonably be classed as such, is that it requires additional parts. But these reduce rather than increase the labor and

expense of engine brake maintenance, with one exception, that it requires more frequent adjustment of driver and tenderbrake piston travel than with the automatic alone, due to the increased labor these brakes perform. To offset this, however, there is less reversing of the engine.

The double-check valve and straight-air valve are the only additions to standard brake parts. Several of these have been in use for nearly two years and many for shorter periods, yet no case has been reported where repairs have been required. The only parts liable to require renewal are the small leather seats.

Transmission of Compressed Air for Power.

In connection with the use of compressed air for power purposes many questions of a more or less technical nature have to be confronted, and the one "Which is the most economical size of pipe to use for the transmission of the compressed air from the place of compression to that of consumption?" is by no means the easiest to answer.

It is evident to every one that the larger the pipe the greater will be the economy of transmission. On the other hand, however, the price of pipe increases so rapidly for the larger sizes that the point is soon reached when the interest on the increased first cost exceeds the saving due to the reduction of friction produced by the passage of the air through the pipe.

Only the other day the writer was asked which was the cheapest size of pipe to use on a certain job, everything considered. The inquirer was surprised that he did not get an offhand answer to the question, and evidently got the impression that the writer was not as much of an engineer as he claims to be.

An account of what the correct determination of the answer would involve may prove instructive to those busy business men who, although claiming that time is money, are constantly expecting their engineering friends to answer their technical questions gratuitously.

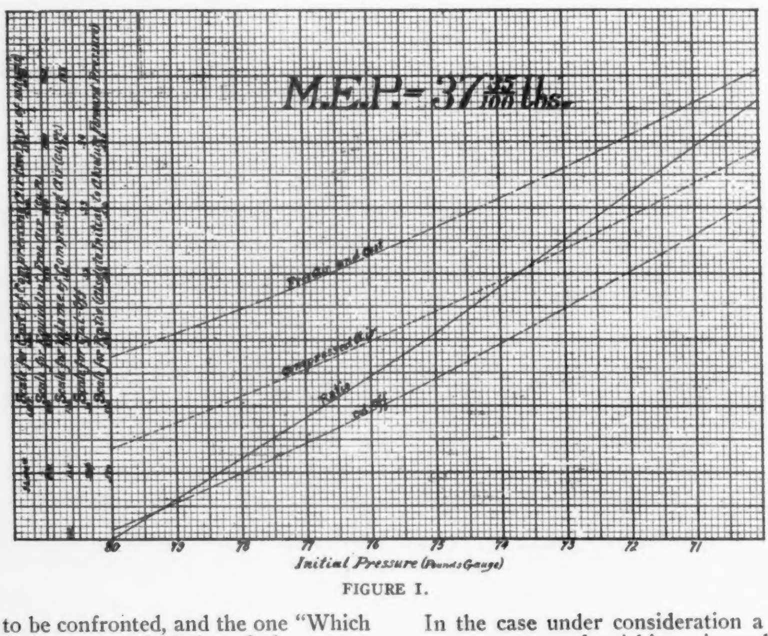


FIGURE I.

In the case under consideration a large compressor was furnishing air under 80 pounds gauge pressure for various purposes, and it was desired to also connect onto this compressor a pump situated in a mine 2,500 feet distant.

It was considered desirable to maintain

the present pressure at the compressor. The pump was of the fly-wheel type, having an air cylinder twice the diameter of the water cylinder. It was provided with a Meyer cut-off valve and was expected to raise 45,000 gallons per hour against a head of 300 feet.

The pressure on the water piston being 300 feet head, or 129.9 pounds per square inch, and making an allowance of 15 per cent. for friction, we see that in an air cylinder of twice the diameter the mean effective pressure must be 37.35 pounds per square inch.

Again, the piston displacement in the water cylinder must be 750 gallons plus 5 per cent. (allowance for slippage), or 787½ gallons per minute, which equals 105.27 cubic feet. The air piston having four times the area, it must have a displacement of 421.08 cubic feet, which, when allowing 7 per cent. for clearance and ports, gives a cylinder capacity of about 451 cubic feet to be filled every minute.

The mean effective pressure equals 37.35 pounds per square inch and is a constant. It must also equal the absolute initial pressure at the throttle valve times R and minus the absolute back pressure, in which R is the ratio of absolute initial to absolute mean pressure during the forward stroke.

In the case of a slow running pump exhausting direct into the atmosphere, we

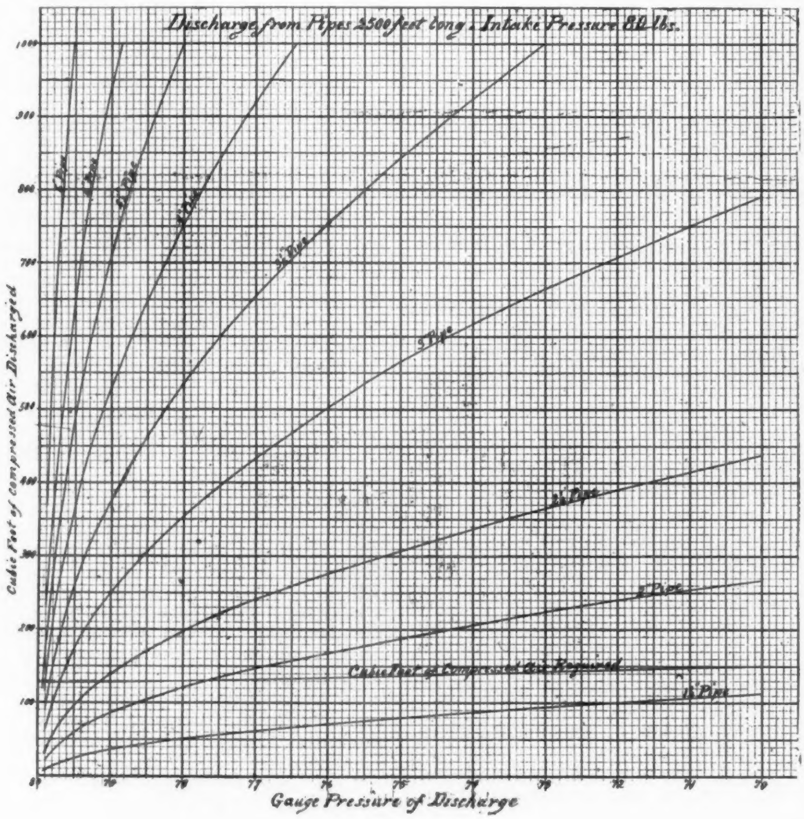


FIGURE 2.

are safe in considering the absolute back pressure as equal to 14.7 + 1. = 15.7 pounds.

This gives, when P equals the throttle valve pressure, M. E. P. = 37.35 = P R - 15.7.

We know that for adiabatic expansion

$$R = \frac{2.451 \left[1 - \left(\frac{1}{C}\right)^{.408}\right]}{C} + \frac{1}{C}$$

In which C equals $\frac{1}{\text{cut-off}}$.

We also know that P × volume is constant for a constant temperature.

Now, using this information and allowing ¼ of a cent as the cost of compressing 100 cubic feet of free air to 80 pounds gauge pressure, we are enabled to plot the following curves:

Having thus ascertained the number of cubic feet of air required, when compressed to different pressures, it remains to be determined what volume will be delivered by pipes of different sizes at various discharge pressures, but a constant intake pressure of 80 pounds.

The most generally accepted formula for the flow of compressed air in pipes is that of D'Arcy, which is

$$D = C\sqrt{\frac{d^5 (P_1 - P)}{w\, l}}$$

In which

- D = cubic feet discharged (measured at discharge pressure).
- P_1 = intake pressure (gauge).
- P = discharge pressure (gauge).
- l = length of pipe in feet.
- c = co-efficient or constant for given size of pipe.
- w = density or weight in pounds per cubic foot (measured at intake pressure).

By reference to tables for c and w this equation may be solved and plotted as shown below for various sizes of pipe, and if we again plot the curve for the required number of cubic feet of compressed air as found by chart No. 1, we can see at a glance the result of using any size of pipe.

We are now able, with the help of the above curves, to make up the following table, in which column four is figured for one year of 3,000 working hours:

Size of Pipe.	Cost of Pipe on the Ground.	10 per Cent of Difference	Cost of Compressing the Air if Said Size of Pipe is Used.	Difference.
2″	$281.25	......	$6195.00	......
2½″	449.25	$16.80	6157.50	$37.50
3″	589.85	14.06	6138.75	18.25
3½″	742.20	15.46	6135.00	3.75
4″	843.75	10.13	6133.50	1.50
4½″	1015.62	17 19	6132.50	1.00

It appears that, in the matter of first cost and running expenses, there is an advantage in favor of the 3-inch pipe. But this advantage is so slight that, when the probable temporary nature of such work is considered, we feel certain the 2½-inch pipe would be the best size to use on this job.

If the distance between the compressor and pump was less, the advantages of using a 3-inch pipe would be greater, while, on the other hand, if the distance was increased sufficiently, we should have to use a 3-inch pipe in order to get sufficient power at the terminus.

L. C. BAYLES.

A Demonstration of Pneumatic Tools.

A demonstration of pneumatic tools was recently given at Westminster, London, England, at the works of the Consolidated Pneumatic Tool Company, which concern represents the Chicago Pneumatic Tool Company in England, and brought forth an emphatic endorsement from the usually conservative *Pall Mall Gazette.*

In describing the demonstration and commenting on the achievements of the pneumatic tools, the *Pall Mall Gazette* said in part:

"The underlying principle, as technicians are aware, is the application of air compressed in a high degree to tools of various construction, which automatically work a drill, or hammer, or what not, fixed at the end. The operator controls the instrument by a steel handle shaped to the hand like the haft of a saw, as well as by an arm formed by the joint of the air tube, and where he needs a hand to direct the tool more carefully, he can adjust the butt of the instrument to his breast or shoulder like an ordinary brace-and-bit. To see a fitter take

up a breast drill and put holes through a ½-inch plate was an experience.

"A hand-sized rock drill was picked up from an unpicturesque heap, the air-tube was screwed up and the pressure shut on; in a few seconds the drill was nosing its way through a block of limestone. The only accompaniment to the grinding sound was a tiny fountain of white powder and dust coming away in a wisp of smoke. Mr. Diem added that lately an operator with this drill had bored three 5-foot holes while the older-fashioned tool alongside was being fixed upon its tripod. The entire weight of the drill was 40 pounds, it used only 42 cubic feet of air per minute, and a blast arrangement kept the hole clear of all obstructions, a point worth considering in boring without water. The tube was then switched onto a pneumatic chisel, and presently this was cutting pieces of the thickness of a Bock cigar from a steel plate set on end. It was equally effective in dressing stone. Another tool put a "tap" into holes already drilled, and another expanded and cut boiler-tubes away from the inside, so that they could be released from the end plate at a touch. The operator is relieved from the weight of the tool by a pulley arrangement and swung weights. Another tool, a hammer this time, put a head on copper stay-bolts with perfect roundness and finish, and this led up to the wonders of the tool as a riveter.

"The deck-riveter is, for the sake of easy transit, mounted on a sort of carriage, like an outrigger on wheels, and by its use a youngster of eighteen, it is claimed, rivets 2,000 rivets per day in one of the Birmingham shops. In the room, where three boiler-plates had been set up and bolted, rivets of an inch and a quarter thick were brought in from the forge and driven home in a fraction of the usual time; finished, moreover, with perfectly rounded heads with an excellent flush. The celerity attained with the ¾-inch rivet was amazing. One riveter keeps two forges going. Where a rivet is condemned, the head is chipped off, the drill is put through and the remainder is crumbled away, all by pneumatic process, and in a tithe of the time spent over a bad rivet in the ordinary way. In the open air we saw a Tynan heater belching air and oil-spray upon a ½-inch plate, and this burst of flame, when forced through a shaped fire-brick, narrowed the heated area down to the size of a shilling. A ½-inch plate, it is said, 3 feet across, has been rendered white hot inside of six minutes. Another development of the pneumatic idea was a giant nipper, which, at a touch of the hand, nipped a cold steel rod into pieces in a way to make a crustacean blush without boiling.

"Clearly, the possibilities of the pneumatic tool are enormous, and one fails to conceive, even by taking thought, all the uses to which it has already been put. An American workman has adapted it to the painting of tinware baths, and the paint is sprayed by a draft of air instead of being slopped about by hand, as it used to be. This means a surprising saving of time, not to mention the improvement in the evenness of surface. For similar work where enamel is used, the old process used to be to sprinkle it by hand or out of a pepper castor; the new process is to spread it on a disc or plate, and then tap the plate with a tiny air hammer going at 3,500 taps to the minute. But, after all, the chief conquests of the pneumatic idea have been in the dockyard and boiler-sheds, the machine shops and masons' yards of two continents. The invention is American, but that fact has in no way impaired its acceptance in Europe. The Flensburger Company, we learn, pays a bigger dividend, and possesses in its new yard more modern machinery than any other shipbuilders in Germany; it is a staunch user of pneumatic inventions."

The Report of the South African Miners' Phthisis Commission.

Publicity has been given to the report of the South African Miners' Phthisis Commission. This Commission was appointed by Lord Milner, December, 1902, to inquire into the extent phthisis prevails, to ascertain the cause of the disease, and to make recommendations as to preventative and curative measures, which should be adopted either by legislation or otherwise.

The Commission was composed of Mr. H. Weldon (Chairman), Dr. C. L. Sansom, Mr. R. M. Cutlin, Dr. W. T. F. Davies, Mr. Francis Drake, Dr. S. Hawarden, Mr. J. Harry Johns, Mr. E. Perrow, Mr. J. R. Williams, Dr. C. Porter, and Mr. J. Strat-

ford (Secretary). The mine managers of the Witwatersrand were requested to allow the medical officers attached to the mines to supply information. In addition, upwards of 200 mines were circularized, but from these only forty-five replies were received.

The Commissioners state that miners' phthisis in the Transvaal is largely confined to miners who have worked for some time in metalliferous mines, and who have been engaged more particularly in rock drilling in the gold mines. Of the 4,403 miners officially declared to be working underground in the gold mines of the Witwatersrand, 1,210 were medically examined by the Commission. Of this number 187, or 15.4 per cent., were certified by the examining doctors to be affected by the disease, while a further 88 were suspected cases. These numbers quite confirm the impression as to the extent to which miners' phthisis prevails and the urgent need for preventative measures. Especially so is this the case when it is known that the malady cuts off men before their prime, for the average age at death is only 35.5 years. Of the 187 miners certified as suffering from phthisis, 20, or 10.7 per cent., gave a family history showing a tendency to pulmonary consumption. The malady seems to be especially prevalent among the rock-drill miners, for, of the 187 miners certified as suffering from the disease 172, or 91.98 per cent., had been employed on rock drills. The majority of these men had only worked 6.4 years on the machines. As some had worked in other countries than the Transvaal, they had therein, at any rate, incurred the risk of contracting silicosis. The detection of the disease in the early stage is not always easy. It is stated, and the announcement is very important, that there is no appreciable amount of tuberculosis among the miners.

The Commission specially investigated the following: (1) Character and harmful properties of the inorganic particles held in suspension in the mine atmosphere; (2) Mine ventilation, including the composition and quantity of the air circulating throughout the working places in the mine, also the composition of the gases given off during blasting operations; (3) Mine sanitation; (4) Living conditions of the miners.

During the operations of blasting, drilling, shoveling, etc., especially in the dry gold mines of the Witwatersrand, large quantities of dust are given off. It is a common opinion that the phthisis of gold miners, or silicosis, is a consequence of the inhalation of minute particles ot inorganic material with which the mine is charged. In support of this belief there is the fact that while the disease is not entirely confined to rock drillers, yet it is more prevalent among them than in any other class of underground workers; also that of the different kinds of work undertaken by rock-drill miners, "raising" is the most dangerous, largely owing to the circumstance that in "raising" the holes which are bored by the rock-drill machines have an upward inclination, into which water is not usually injected, in contradistinction to boring "wet holes," which are either horizontal or have a downward inclination.

During the boring of a hole by rock-drill machinery there is sometimes as much as 0.185 grain of dust in a cubic foot of air. This dust on microscopical examination is found to be composed of exceedingly sharp-pointed siliceous particles. In order to combat the evil effects of dust, especially in mines where water is not available for laying it, the wearing of a respirator is recommended by the Commission. The Commission states that it is not in a position to recommend any special form of respirator.

As the Witwatersrand mines are ventilated mostly by natural means, the supply of fresh air in the mines varies with the atmospheric conditions on the surface. In the ends of drives, rises and winzes the atmosphere is harmful, since it is liable to be contaminated by noxious gases evolved during blasting or exhaled from the lungs and bodies of the miners. Systematic ventilation is therefore recommended, "so that fresh air may be caused to enter each mine in sufficient quantity to sweep through the drives (to within a reasonable distance from their ends), and thus dilute and carry away up to the surface the injurious gases and particles of organic and inorganic matter that may be held in suspension in the air." Attention is also directed to the composition of the air from the compressor and the danger that accompanies the use of inferior oils (or oils of low flash point) for lubricating the air cylinders of the compressor engine. Lubricants used for this purpose ought to be incapable of being decomposed into, or of giving off, injurious products under

the conditions they are subjected to in the air cylinder of the compressor. A solution of soft soap can satisfactorily replace the oil.

While acknowledging that the bulk of the medical evidence points to miners' phthisis being the result of the action of dust upon the lungs, the Commissioners also discussed the point as to whether deleterious gases in the mines might not act as predisposing causes or tend to accelerate the disease. "Gassing" frequently occurs in the Witwatersrand mines. Before blasting, the air in the mines was found to contain: Oxygen, 20.38; carbon dioxide, 0.11; carbon monoxide, 0.13; nitric oxide, 0.0004; while after blasting the amounts respectively were 19.90, 1.59, 0.39 and 0.0078.

The Commissioners find fault with the general sanitary condition of the mines, the manner in which the disposal of human excreta is arranged for and the absence of provision of adequate facilities for washing, also for changing and drying the clothes of the miners.

Accidents Due to Combustion Within Air Compressors.*

The phenomenon described by Dr. Ledoux, involving an apparently abnormal high temperature in the air cylinders of compressors, has not been, so far as I know, discussed in technical literature. The common formula for the adiabatic compression of dry air does not account for heat sufficient to flash ordinarily decent cylinder oils, nor do the text-books include in their theoretical statements any quantitative consideration of the effect of leaks in the ideal machines which they contemplate.

At the beginning of the stroke the air in the cylinder has come from three sources, namely, that which was left in the cylinder clearance spaces on the previous stroke; that which has leaked in from the discharge valves and past the piston; and that which has been drawn in from the atmosphere.

The air which was left in the clearance had, when under compression, the temperature of the discharge; but on the retrograde movement of the piston it expands and performs work, falling in temperature to the temperature just previous to compression; therefore, the clearance air need not be considered in this investigation.

The air coming from the leaks expands from the high pressure of discharge to the low intake pressure of the cylinder, without performing work except in creating velocity in its own mass; but as it comes to rest in the cylinder, its temperature becomes that of the discharge.

The air is presumed to be dry and the compression adiabatic. I am well aware that compressors universally have water-jackets, but I credit these with no cooling effect on the air during compression. The lubricant on the cylinder walls and the thin film of air in actual contact with the jacketed surfaces may experience a slight cooling; but the mass of air is so remote from these influences as to be unaffected thereby. The presence of watery vapor in the air itself will sometimes keep down the temperature, and. more often, unskilful readings of a thermometer placed at a distance from the cylinder will give apparent results much lower than the temperatures actually existing directly at the discharge valves.

Applying the formula to a single-stage compressor, at sea level, compressing to 88 pounds or 7 atmospheres, the atmospheric air being at 62 degrees Fahr., we have the following temperatures of discharge, when the leaks of piston and discharge valves are as stated:

Leak.	Temperature.
0	459° Fahr.
0.01	466 "
0.02	475 "
0.04	489 "
0.06	506 "
0.08	524 "
0.10	544 "
0.12	566 "
0.14	589 "
0.16	615 "

EFFECT OF LEAKS ON TEMPERATURE OF COMPRESSED AIR AT SEA LEVEL.

This, however, is not a full presentation of the case of the single air cylinder compressor, for the reason that a very large proportion of compressors, in this country at least, are used at points high above the sea level—4,000 feet is a moderate assumption for an example.

* Abstract of remarks by Mr. E. Hill in a discussion of a paper by Dr. A. R. Ledoux before the American Institute of Mining Engineers, as published in COMPRESSED AIR for June, 1903.

The barometer would be at 25.7 inches, and to produce 88 pounds gage pressure of this thin air requires eight compressions. Therefore, at 4,000 feet the same heat is developed in producing 88 pounds as is developed in producing 8 atmospheres or 103 pounds gage at sea level. We have therefore:

Leak.	Temperature.
0	496° Fahr.
0.01	504 "
0.02	512 "
0.04	530 "
0.06	549 "
0.08	570 "
0.10	593 "
0.12	618 "
0.14	646 "
0.16	675 "

EFFECT OF LEAKS ON TEMPERATURE OF COMPRESSED AIR AT 4,000 FEET ALTITUDE.

Either of these cases—at sea level or at a higher altitude—shows the possibility of a temperature fully sufficient to produce gas from the oil lubricant and to cause it to burn, creating excessive heat and an increased development of gas, quickly followed by explosion.

It will be seen that there is a rapid increase in heat as the leak increases. The calculation is made on leaks which are percentages of the cylinder capacity. A leak is constant, whereas the intake of the compressor depends on the speed of the machine. It follows therefore that a leak of, say, 2 per cent. of the intake capacity of 125 revolutions becomes 10 per cent. when the compressor is slowed down to 25 revolutions per minute. This quite agrees with experience. In several cases of violent explosions brought to my notice the compressor was running slowly at the time. The oil feed was probably adjusted to the maximum speed of the machine, and thus was excessive for the slow speed. A larger proportional leak—a liberal quantity of oil—and the result is easily comprehended.

The remedy for these dangerous conditions is to have the compressor made with compound air cylinders. Such compressors, properly proportioned, when compressing to 8 atmospheres or 103 pounds gauge, would develop under normal conditions 245 degrees in each cylinder.

Compound compressors are less liable to have leaks than are single cylinder machines, because there is less difference in pressure between the discharge and the intake side of the pistons.

But in the best modern designs of compressors, the harmful effects of leaks are entirely overcome by causing the air which leaks past the pistons to go through an intercooler and to be thoroughly cooled before it again enters the cylinders for compression. This keeps the temperature down, and pressures of from 3,000 to 5,000 pounds are obtained without inconvenience or anxiety.

It should be remembered that combustion is more vigorous under higher pressure than in the open atmosphere. No doubt there is likewise an easier oxidation and a lower flash point for oil under pressure in the cylinder than under ordinary conditions outside. In many cases a noisome gas is generated and distributed in the mine long before the final explosion. Workmen at the front, instead of receiving pure, cool air from the exhaust of the drills or other machines, breathe a foul, stupefying and sometimes fatal mixture.

[This appeared in a recent issue of the *American Machinist* with the following comment: "We publish this more because it is an explanation of a serious matter offered by one whose opinion commands respect than because we agree that the effect of leakage is apt to be serious."—ED.]

Building the Cleveland Stone Company's Power Plant.

Readers of COMPRESSED AIR will remember the large compressed air power plant for the North Amherst, Ohio, quarry of the Cleveland Stone Company, mention of which has been made several times in these columns. Through the courtesy of the Ingersoll-Sergeant Drill Company, which concern has the contract for furnishing the complete plant, we are enabled to show the progress being made in its construction.

The accompanying illustration shows the two huge Corliss compressors being erected. The steam cylinders are in position, and the air cylinders are being connected. They are both of the Ingersoll-Sergeant Corliss condensing type with 48-inch stroke and have a combined capacity of 9,215 cubic feet of free air per minute.

What makes the plant of special importance in quarrying circles is not so much the size, which is nevertheless unusually large, but the fact that the entire power for the quarry is to be supplied by this plant which is installed by one company alone, and that certain radical changes in the whole system are planned, which, it is claimed, will greatly increase the output and reduce cost.

Naturally the quarrymen all over the country are looking at this plant with all interest, and on its success or failure will depend the course of many others. There seems no reason to believe that two such experienced concerns as the Cleveland Stone Company and the Ingersoll-Sergeant Drill Company, would enter into such an undertaking unless they were assured of its success, so this plant has the promise of being one of much importance to the compressed air trade.

PARTIALLY COMPLETED POWER PLANT OF THE CLEVELAND STONE COMPANY.

Notes.

The British Compressed Air Cleaning Company, Ltd., the progress of which was noted in last month's COMPRESSED AIR, has just established a separate company in Wales under the title of the South Wales Compressed Air Cleaning Company, Ltd. The offices of this concern are at Cardiff.

COMPRESSED AIR has received a copy of the thirty-seventh edition of Gurley's Manual of American engineers' and surveyors' instruments through the courtesy of Messrs. W. & L. E. Gurley. It contains much valuable information which will be of use to those planning and building compressor plants or for quarrying and tunneling operations.

A new appliance has recently been added to the fire brigade of London,

England. It is known as a first-aid machine, and is always in readiness to answer the first call. It consists of two cylinders, the large one containing air and water, and the small one containing compressed air to a pressure of 1,000 pounds to a square inch. The compressed air is used to work a small but powerful stream at the fire, pending the arrival of the steamers.

While molding machines are no longer a novelty, the Tabor Manufacturing Company, of Philadelphia, has recently placed on the market several types of pneumatic molding machines which will interest all who keep in touch with the work of the foundry. In a catalog just issued these machines are described at length, and a number of illustrations shown. There are also pictures of the interior of the Tabor Company's shop. This same company will shortly issue another catalog covering hand-ramming molding machines.

The use of compressed air for the operation of pneumatic tools has become a prominent feature in the economics of large manufacturing establishments. Especially is this true of the shipbuilding industry. In each of the larger shipyards several hundred pneumatic tools are now in use. At the plant of the New York Shipbuilding Company, in Camden, N. J., there are now in use about 400 portable riveters, calkers, drills, etc. Air pressure of 110 pounds per square inch is supplied by an air compressor capable of 5,000 cubic feet of air per minute.—*The Iron Age.*

The Colne *Times*, of England, reports a remarkable invention. After about 22 years' labor, Mr. Joseph Hoskin, of 39 Alexandra road, Morecambe, formerly of Colne, has patented an injector apparatus for the purpose of driving engines with compressed air instead of with steam. It is claimed, at least, that the invention will save 65 per cent. in coal used for a boiler, and it will work, if desired, with compressed air only in the present state of boilers, without removing same. Further, Mr. Hoskin claims that in connection with motor cars his discovery should displace petrol as a motive power.

Liquid hydrogen is by far the coldest liquid known at the present time. At ordinary atmospheric pressure it boils at —422 degrees F., and reduction of the pressure by an air pump brings the temperature to —432 degrees, at which the liquid becomes a solid, resembling frozen foam. According to Professor Dewar, to whom the credit is due of having liquefied hydrogen in 1898, the liquid is a colorless, transparent body, and is the lightest liquid known to exist, its density being only one-fourteenth that of water; the lightest liquid previously known was liquid marsh gas, which is six times heavier. The only solid which has so small density as to float upon its surface is a piece of pith wood.—*Cassier's Magazine.*

Whenever an operation or a trade or an industry tends to extend, or when it is desirable or necessary that it should extend, mechanics and machinery must come into action. Manual or animal effort soon reach the limit of their power and efficiency; and whatever machinery is capable of doing it performs with incomparable patience and accuracy. The increased mining depth and the increased demand for coal have forced machinery on by leaps and bounds. To wind the coal in the United Kingdom alone represents approximately a million of horsepower, and the hauling and pumping and ventilating will represent probably an equal amount of power. This could not be provided either by human beings or animals, and if provided would be impracticably expensive.—*Science and Art of Mining* (Eng.).

Pneumatic drills are highly praised in a paper recently read before the Institution of Civil Engineers by Mr. A. F. Yarrow. In his ship yard it is now the practice to drill the rivet holes in the inside strakes of plating with electric drills. The plates are then sheared and put in position. The outer strakes of plates are next put in place and drilled by the pneumatic tools, the inner plates acting as jigs. Mr. Yarrow considers it impossible to have more accurate workmanship, for the system places it beyond the power of the men to do bad work. This method of drilling does not affect adversely the cost or speed of construction. In punching a plate, a gang of men

is employed to handle it, and while punching it is much more rapid than drilling, there are many more men employed. Moreover, punching must be done on one plate at a time, while several plates can be drilled simultaneously. —*The Engineering Record.*

An interesting description of the improvements being made on the Pennsylvania Railroad, between Pittsburg and Philadelphia, is to be found in the issue of the *Engineering News* for September 24. It includes an account of the construction of the Gallitzen tunnel, which parallels the old Allegheny tunnel. As usual, compressed air figures very prominently in its construction. A single heading is driven from each end of the tunnel and in each there are in operation four drills operated by compressed air. Two of the drills are mounted on columns. Two other drills, mounted on tripods, widen out the heading made by the others. A steam shovel operated by compressed air is being used to load the cars at the end of the heading. Despite the fact that there is only a single track in the tunnel, thereby limiting the use possible under such conditions, this compressed air shovel is regarded by the contractor as a decided success in its tunnel work.

Referring to the extended use of pneumatic tools, Mr. Robinson, of Glasgow, one of H. M. Inspectors of Factories, gives some interesting facts relating to the development of mechanical devices. Among them he cites jobs formerly done by journeymen which can now, with these pneumatic tools, be undertaken by apprentices. In one case he heard of a job which was finished by an apprentice in three or four hours. Under former conditions that same work would have occupied an average journeyman more than a day. On the other side of the question, which, of course, must be regarded, Mr. Sedgwick, of Leicester, comments upon the effect of mechanical development upon the smaller trades, which gives support to the impression that the days of the "Little Mester" are numbered. This gentleman states that the continued introduction of labor-saving machinery, and the consequent subdivision of labor, is slowly, but surely, directing the trade into the hands of large employers and limited companies, and with these the little man has but very slight chances of successfully competing in either the home or foreign markets.—*Hardware Trade Journal* (England).

At the Air Brake Convention, held in Colorado Springs, last April, there was a series of four tests of air pumps. These tests were briefly and substantially as follows:

The first test consisted of a drilled diaphragm placed either in some convenient point near the brake valve or at the rear of the tender, and the pump run at about 100 or 140 strokes per minute, being required to keep up a pressure against a 3-16 inch opening in the diaphragm.

Test No. 2 consisted of a similar arrangement described in No. 1, except that the speed of the pump was about 60 or 70 strokes per minute, and was required to keep up a pressure against an escape port 3-32 inches in diameter.

Test No. 3 consisted of a gauge screw into the bottom head of the air cylinder of the pump, and at a slow speed, pressure passing by the packing rings would pile up in pounds in the suction end of the cylinder and show on the gauge.

Test No. 4 was called the "oil cup test" and was made by opening the oil cup on the top end of the air cylinder, and running the pump at a slow speed. If air blew out of the oil cup on the down stroke, it meant a leakage of pressure past the packing rings. This degree of leakage either passed or condemned the pump.

Under the title "A Notable Example of Central Station Supply of Electric Power and Light," the *Engineering Record* published in its issue of September 26 a description of the new building of Marshall Field & Co., of Chicago. As usual, compressed air is called upon to play no unimportant part. There are two 11½-inch by 12-inch by 5½-inch by 21-inch Ingersoll-Sergeant air compressors which supply air at 40 and 20 pounds gauge pressure for operating elevator doors and sewerage ejectors, respectively.

One 8-inch by 8-inch vertical air compressor of the same make furnishes compressed air at 60 pounds pressure for physicians and dentists occupying the upper floors of the building. This air is first washed by being passed through a

water bath and then forced through a special filter containing sterilized cotton gauze. One 8-inch by 8-inch Christensen compressor supplies air at 80 pounds pressure for carpet renovators. The air compressors are all chain-driven from variable speed motors. The pneumatic cash carrier system consists of two No. 9 Root blowers, which are driven by 75 horse-power motors and two No. 7 Connersville blowers which operate by a 40 horse-power motor. The blowers are of the piston type and are operated on approximately 2 inches of vacuum supplied for the 200 cashier stations.

The eighty-third meeting of the American Institute of Mining Engineers was held in New York, October 13th to 17th. The session was in all respects a very successful one and was largely attended by engineers prominent in the mining industry of the country. The headquarters of the Institute were made at the Murray Hill Hotel, but the sessions were held in various halls of kindred organizations, and educational institutions. A series of very interesting papers were presented, giving some important information as to the mines and mining methods in various portions of the country. Then there were trips to several metallurgical plants in the vicinity of New York, an inspection of the Rapid Transit Subway and a visit to the United States Military Academy at West Point. The members also saw something of Columbia and New York Universities. A reception and dance at Sherry's and an informal reception at the American Museum of Natural History were pleasant interruptions in the routine of the session.

The only paper in which compressed air primarily figured was a discussion of Mr. Clarke's paper "Electrical Apparatus for Coal Mining" by Mr. W. L. Saunders. This discussion has already appeared in the columns of Compressed Air. Incidently, compressed air was mentioned frequently and its prominence in the mining industry of the country was frequently demonstrated.

Many different designs of steam-driven pumping plant have been used for this purpose from time to time, but, given suitable conditions, nothing has proved so simple and effective as the method of raising deep well water by compressed air introduced by Mr. William H. Maxwell, A. M. I. C. E., at the Tunbridge Wells Waterworks in the year 1900. This is apparent from a study of the data arrived at by a series of careful tests with the plant in question, and the experience of its several years' satisfactory working, as recently described in an interesting paper read by Mr. Maxwell on the subject before the British Association of Waterworks Engineers at Bolton, an abstract of which we hope to give in our next issue. The paper is of greater interest from the fact that the plant in question is one of the first permanently installed in this country on a fairly large scale for the purposes of public water supply. Engineers as a rule have hitherto looked somewhat suspiciously upon the use of compressed air for such a purpose, owing to their doubts as to the economy of this system and the want of actual experience upon which to base their designs for such a plant. They will be greatly assisted in this direction by the results of experience supplied by Mr. Maxwell in his paper, who has now demonstrated by a series of independent and accurate trials that this method of raising water, where proper conditions favorable to its adoption obtain, may be employed with perfect success and economy of working. Even with coal costing the high figure of 25s. 5d. per ton, the fuel cost of raising the water through a 100-foot lift is a fraction under a penny per 1,000 gallons; and when the smaller capital charges are also taken into account, the system has very decided advantages where the proper proportions of "immersion" of the air-pipe to the "lift" of the water can be secured. Considerable saving in labor is also effected from the fact that the well may be several miles distant from the main pumping station, where any additional machinery may come under the supervision of the existing staff, and the air be conveyed in pipes to the wells, where no attendance or buildings are required. The air is discharged at a suitable pressure at the bottom of the well, which, in the present case is 350 feet deep, and the water is thus made to flow at the surface at the rate of over 30,000 gallons per hour. —*Sanitary Record* (Eng.).

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U.S. PATENTS GRANTED SEPT., 1903.

Specially prepared for COMPRESSED AIR.

737,681. VALVE. John B. Waring, East Orange, N. J., assignor, by mesne assignments, to Waring Patents Company, New York, N. Y., a Corporation of New York. Filed July 1, 1901. Renewed Feb. 4, 1903. Serial No. 141,931.

737,682. REDUCING-VALVE. John B. Waring, East Orange, N. J., assignor, by mesne assignments, to Waring Patents Company, New York, N. Y., a Corporation of New York. Filed Nov. 17, 1902. Serial No. 131,601.

737,709. BUMPER FOR RAILWAY-CARS. Thomas Collins, San Jose, Cal. Filed Apr. 18, 1902. Serial No. 103,488.

A device consisting of a suitable body secured to the car, a secondary member pivoted to said body and formed with a plurality of chambers, reciprocating plungers in said chambers, and a cross-head pivoted to the coupling of the car and connected to said plungers, said plungers being formed with a small perforation and a check-valve leading to said chambers substantially as and for the purpose set forth.

737,906. COMPRESSED-AIR OR OTHER SIMILAR BRAKE. Adolphe Chaumont, Brussels, Belgium. Filed July 23, 1901. Serial No. 69,352.

For the purpose of effecting the adjustment of the brakes for a certain stroke of piston, a device utilizing the screw-brake and consisting in providing parallel with the rod of the screw-brake a graduated rod provided with

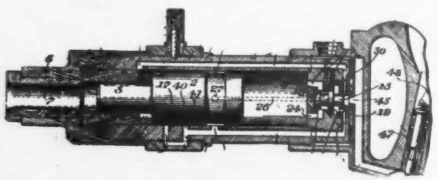
an index in front of which is displaced the nut or its continuation which attains respectively the positions of the rod when the brake-gear reaches the minumum and maximum positions of piston stroke respectively, this latter remaining motionless owing to the provision of an aperture in the rod.

737,941. VALVE OR CUT-OFF FOR TANKS. Peter J. Leithauser, Clarendon, Tex. Filed July 2, 1903. Serial No. 164,050.

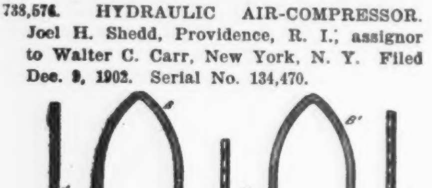
738,102. PNEUMATIC-CARRIER SYSTEM. Wilbur G. Davis, Newton, Mass., assignor to the Single Tube Transmission Company, Boston, Mass., a Corporation of Maine. Filed Jan. 2, 1903. Serial No. 137,378.

A pneumatic carrier system employing a normally dead transmission-tube and having one or more motor-driven substation pressure creating devices.

738,546. STROKE-CHANGING MECHANISM FOR PNEUMATIC TOOLS. Julius Keller, Philadelphia, Pa. Filed Dec. 8, 1902. Serial No. 134,273.



738,576. HYDRAULIC AIR-COMPRESSOR. Joel H. Shedd, Providence, R. I.; assignor to Walter C. Carr, New York, N. Y. Filed Dec. 9, 1902. Serial No. 134,470.



A hydraulic air-compressor, a series of horizontal air-bars communicating at their ends with a submerged air-chamber and means for throttling the air after it enters the air-bars from the air-chamber to secure its more even distribution throughout the length thereof, substantially as described.

738,583. PNEUMATIC MASSAGE APPARATUS. Robert Watson, Scranton, Pa., assignor of one-half to Charles A. Kram, Washington, D. C. Filed Oct. 10, 1900. Serial No. 32,566.

738,690. EXPLOSIVE-ENGINE. Jesse D. Lyon, Pittsburg, Pa. Filed Jan. 28, 1902. Serial No. 91,591.

A gas-engine, provided with a cylinder, an air-compressing chamber exterior to the cylinder and communicating with the interior thereof, exhaust-ports leading outwardly from the cylinder, and a mixture-valve chamber provided with a compressing-valve having check-controlled inlets opening into its interior, and a port leading from the compressing-chamber to the cylinder.

738,959. PNEUMATIC UNDERBLAST AND STACKER. Aart H. Van Houwelingen, Pella, Iowa. Filed May 21, 1903. Serial No. 158,164.

In combination with pneumatic stacker apparatus, an endless traveling carrier to feed the same, said endless traveling carrier comprising a lower chaff-section and an upper straw-section, said sections being angularly disposed with reference to each other, substantially as described.

739,025. INNER TUBE FOR PNEUMATIC TIRES. Theron R. Palmer, Jeannette, Pa. Filed April 14, 1903. Serial No. 152,505.

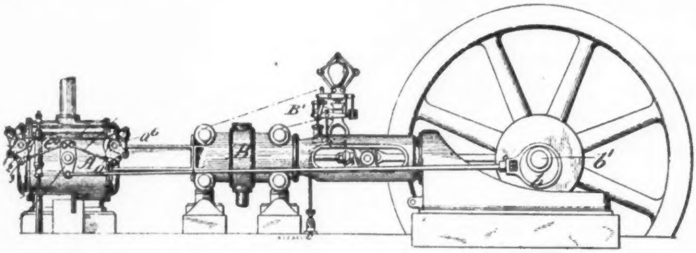
739,134. TRACKER-BOARD ATTACHMENT FOR PNEUMATIC MUSICAL INSTRUMENTS. Alfred Anderson, Cambridge, Mass. Filed May 8, 1903. Serial No. 156,226.

An automatic musical-instrument player, the combination with a tracker-board and a perforated music-sheet, of a chamber having an open bottom adapted to rest against the music-sheet, guide.

739,972. PNEUMATIC ATTACHMENT FOR CHAIRS. Gustaf B. Anderson, Chicago, Ill. Filed Dec. 30, 1901. Serial No. 87,741.

The combination with a rocking-chair provided with a downwardly-projecting pin on its seat, of a bellows located within its frame and connected near its front and rear ends to each of the rockers of the chair, said bellows comprising a pumping portion and a reservoir having an inwardly-opening valve to contact with said pin, springs located between the upper portion of the bellows and the seat of the chair, a support horizontally and rigidly secured to the bottom of the bellows and having at each of its ends rollers to rest on the floor, a hose communicating at one of its ends with the reservoir, an air-controller or hand-piece on the other end of said hose, substantially as described.

738,920. AIR-COMPRESSOR. George de Laval, Cambridge, and George P. Aborn, Boston, Mass., assignors to the Geo. F. Blake Mfg. Co., New York, N. Y., a Corporation of New Jersey. Filed July 25, 1901. Serial No. 69,639.



An air compressor having a cylinder, a piston, inlet-valves, the combination of a mechanism comprising a toggle for operating said valves, and a device open to the excess pressure in the receiver or reservoir for breaking the said toggle whereby the closing of said valves is retarded and a lesser amount of air than usual compressed.

An air-compressor having a cylinder, a piston and inlet-valves, the combination of a mechanism comprising a toggle for operating said valves, and a device open to the excess pressure in the reservoir or receiver for breaking said toggle whereby the closing of said valves is retarded and lesser amount of air than usual compressed, said device comprising a diaphragm which is affected by said excess pressure, and a piston operated by water-pressure, the valve for which is controlled by said diaphragm and the said valve.

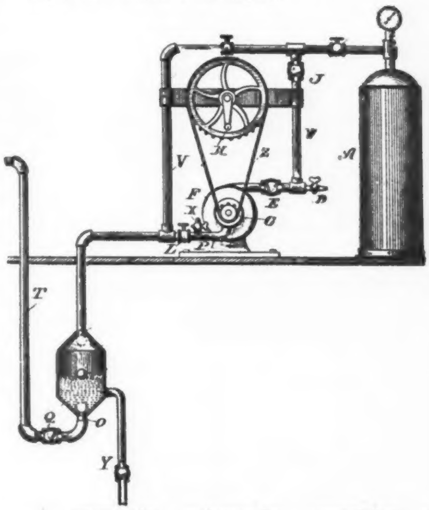
739,231. GOLD-SEPARATOR. William Snee, West Elizabeth, Pa., assignor of three-fourths to John A. Snee, Pittsburg, Pa. Filed Dec. 29, 1902. Serial No. 137,035.

A pneumatic separator, the combination of a casing having a closed hopper-shaped upper portion and a reduced lower body portion open at the bottom, a screen mounted in an opening in the side walls of said hopper-shaped portion, a feed-spout extending into the said upper portion of said casing to a point below the bottom of said screen, and a nozzle extending into said reduced portion and in alinement with said feed-spout to direct a blast of air against the powdered ore entering through said spout, substantially as described.

739,869. PNEUMATIC STACKER. John Henry, Grand Forks, N. D. Filed Dec. 22, 1902. Serial No. 136,270.

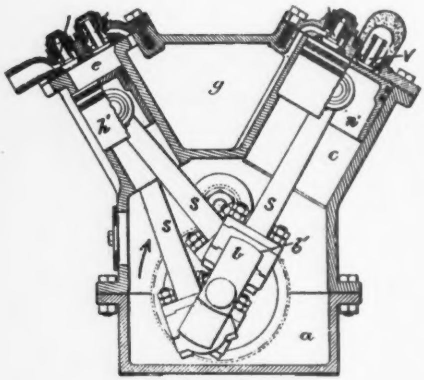
A pneumatic stacker, the combination with a chaff-receptacle, a pocket communicating therewith, and means for discharging chaff into said pocket, of pneumatic devices communicating with said pocket for removing chaff from said pocket and discharging it, and a discharge-outlet for said pocket independent of said pneumatic devices.

739,150. PNEUMATIC WATERWORKS. Edward L. Canon, Quitman, Ga. Filed Feb. 21, 1903. Serial No. 144,393.



A pneumatic waterworks comprising a water-reservoir, an air-pressure chamber, a rotary air-pump, and a two-branched pipe with valves and air-cocks, one of said branch pipes communicating at one end with the water reservoir and the inlet for the air-pump and at its other end communicating with a pipe leading directly from the air-pressure chamber, and the other branch pipe communicating at one end with the outlet from the air-pump and at the other end with the air-pressure chamber substantially as described.

740,133. COMPRESSOR FOR AIR-BRAKE SYSTEMS. Wilhelm K. M. Hilderbrand, Gross Lichterfelde, near Berlin, Germany. Filed Apr. 2, 1901. Serial No. 54,055.



A compound air-compressor for air-brakes and the like comprising two single-acting low-pressure cylinders, two single-acting high-pressure cylinders and pistons, said low and high pressure cylinders being arranged at an angle to each other and with their axial lines converging downwardly, a crank-chamber, a crank-shaft therein, pistons and piston-rods connected with the crank-shaft, and a chamber between the cylinders at their upper ends common to the same and ports connecting said chamber with the cylinders, substantially as described.

740,157. VALVE. Frederick Mertsheimer, Denver, Col. Filed Feb. 24, 1903. Serial No. 144,749.

740,186. VALVE CONSTRUCTION. Louis Schutte, Philadelphia, Pa. Filed Oct. 28, 1901. Serial No. 80,260.

740,306. AIR-BRAKE ATTACHMENT. Felipe B. O'Bannon and Frank J. Chamberlain, Albuquerque, N. Mex., assignors of one-third to George E. Lewis, Albuquerque, N. Mex.; said Chamberlain assignor of his remaining one-third to said O'Bannon. Filed Oct. 11, 1902. Serial No. 126,939.

An air-brake system, the combination with the triple-exhaust connections and the train-line, of means controlling communication between the triple exhaust and the atmosphere, and operating means therefor, said operating means comprising a cylinder having a by-pass and a piston in the cylinder, one end of said cylinder being in communication with the train-line and the other end having communication with the atmosphere, and means acting in unison with the piston to control said atmospheric communication.

740,375. MOTORMAN'S VALVE FOR AIR-BRAKES. John Shourek, Pittsburg, Pa. Filed Dec. 22, 1902. Serial No. 136,226.

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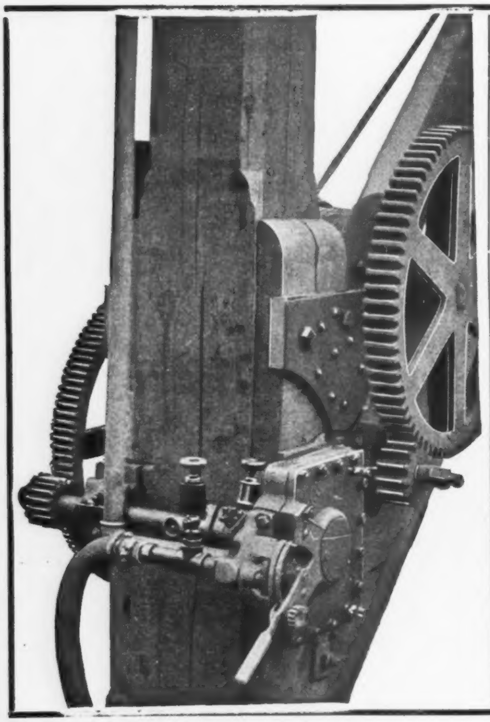

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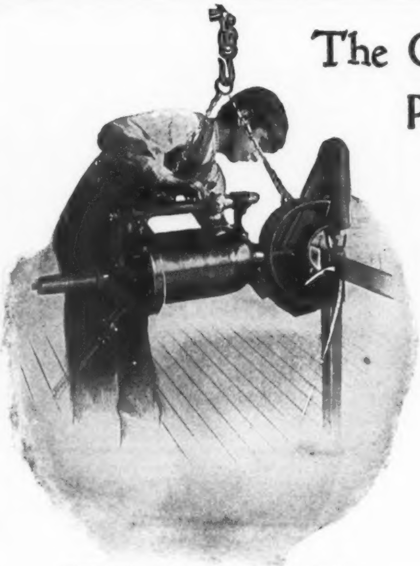

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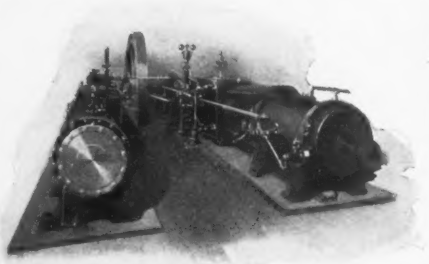

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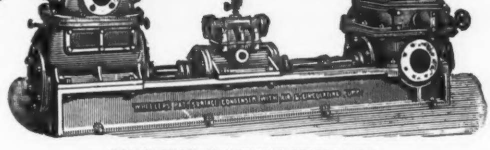

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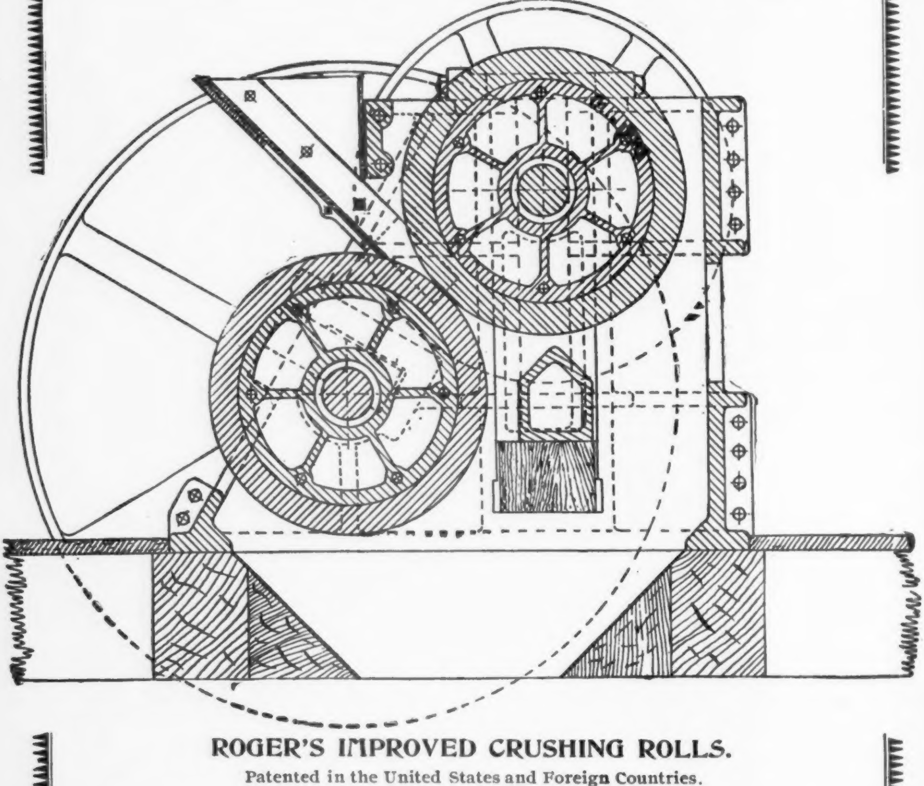

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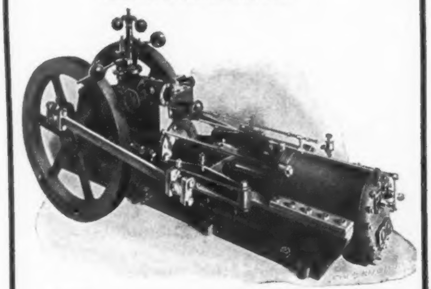

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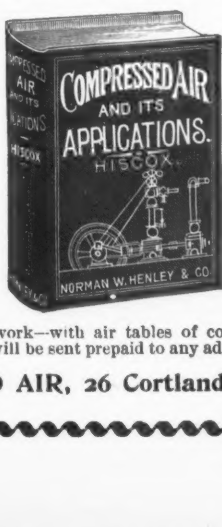

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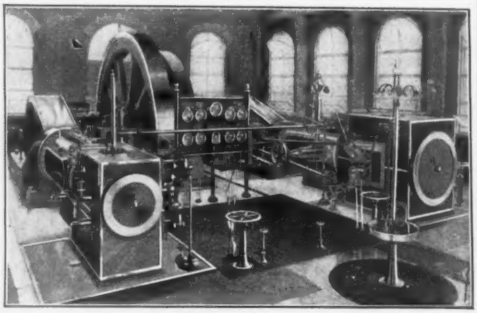

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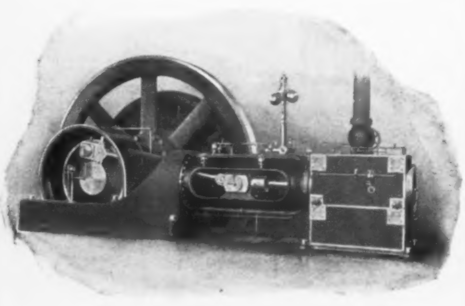

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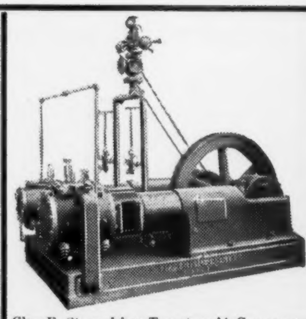

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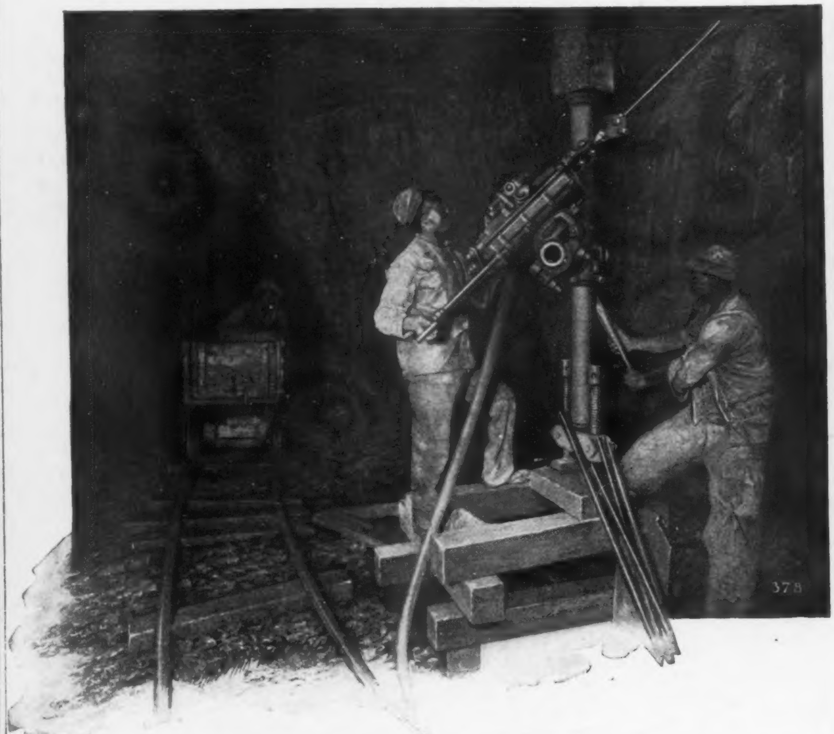

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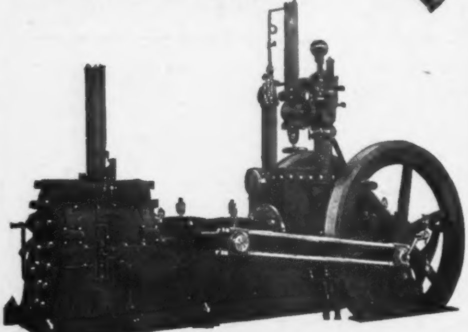

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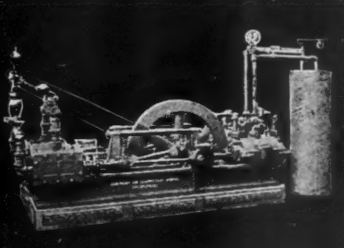

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